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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PESTICIDES AND TOXIC
SUBSTANCES

MEMORANDUM

SUBJECT: EFED's Replacement Review for Determination of Conversion to Conditional Registration of fipronil on In-furrow Application to Corn (PC Code: 129121; Data Barcodes: D277292, D277291, D277289, D278506, D269236)

FROM: William Evans, Biologist 12/5/01
Environmental Risk Branch 1
Environmental Fate and Effects Division (7507C)

TO: Singh Hardip, Environmental Protection Specialist
EFED Information and Support Branch
Environmental Fate and Effects Division (7507C)

Please replace the previous review with the attached review which is slightly modified. The data barcode numbers remain unchanged. If there are any questions about this procedure please see Dana Spatz, ERB1 Acting Branch Chief.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

PC Code: 129121
DP Barcodes: D277292, D277291, D277289,
D278506, D269236

MEMORANDUM

SUBJECT: Updated Environmental Risk Assessment for Fipronil. Corn: in-furrow application and seed treatment.

FROM: William Evans, Biologist 12/5/01
Edward Odenkirchen, Ph.D, Senior Biologist 12/5/01
James Hetrick, Ph. D., Senior Soil Chemist James Hetrick 12/5/01

THRU: Dana Spatz, Acting Branch Chief
Environmental Risk Branch 1
Environmental Fate and Effects Division (7507C) DEC - 5 2001

TO: Arnold Layne, Chief
Ann Sibold, PM Team Reviewer
Insecticide Branch
Registration Division (7505C)

Attached is EFED's amendment to the revised risk assessment which corrects the terrestrial avian LD_{50} per square foot calculations and reduces the risks based on these calculations below the established EPA levels of concern (LOCs). The freshwater aquatic invertebrate chronic risk quotients (RQs) have also been corrected and now exceed the acute risk LOCs for the parent for seed treated with in-furrow applications.

This revision includes data submitted to convert the time-limited conditional registrations of fipronil in-furrow use on corn to an unconditional registration on corn. In addition, EFED has included in this assessment, 1) the proposed additional use of fipronil treated corn seed [ICON 6.2 FS label], and 2) the proposed change to the Regent 4SC label to permit narrow row spacing.

Several conditions were required in order to obtain an unconditional registration on corn, and are listed below.

1. The product must be made a Restricted Use Pesticide due to the toxicity to estuarine invertebrates and birds.

2. To reduce risk it was suggested that use of these products be applied in-furrow at the time of planting.

3. A 20 yard buffer zone which restricted use of fipronil within 20 yards of lakes, reservoirs, rivers, permanent streams, marshes, natural ponds, estuaries, commercial aquaculture facilities, or other bodies of water. Vegetative cover was suggested as an enhancement for all or a portion of the buffer area.
4. Due to the persistence and accumulation of residues of fipronil and its degradates, fipronil should not be applied to the same field in consecutive years.

5. The following studies were required within 3 years after the date of the conditional registration.

   a. A mysid full life cycle study with metabolite MB 46136.

   b. An avian dietary study using the MB 46136 and MB 45950 metabolites due to the high persistence in terrestrial environments.

   c. A fish full-life cycle study to assess cumulative toxicological impact on fish.

6. For above ground use, the following studies were required within three years.

   a. An avian reproduction study with bobwhite quail at maximum expected concentrations

   b. A honey bee acute contact LD_{50}.

   c. A honey bee toxicity to residues on foliage.

EFED has determined that the registrant has complied with all requirements which were specified in the notices of registration with exceptions described below. This determination applies to the REGENT® 4SC, 1.5G, and 80WG insecticide labels.

- The registrant has not included directions which state that due to the persistence and possible accumulation of residues, fipronil should not be applied to the same field in consecutive years. This issue is important and should be included in the labels.

- The mysid full life cycle study for the metabolite MB 46136 was submitted (MRID 452592-03), but found to not satisfy the guideline requirements because the NOEC was not determined. The same case is true for the parent fipronil (MRID 436812-01). While these studies are not critical for the in-furrow corn assessment, valid studies will be required for the rice, fire ant, and proposed cotton registrations.

- The avian reproduction study (MRID 429186-22) did not determine the LOEC, and a new study would normally be required if the proposed use produces estimated maximum environmental concentrations greater than the highest level tested. However, the expected maximum environmental concentration for in-furrow applications on corn is below the highest level tested (10 mg/kg-diet) and a new study will not be required for in-furrow applications to corn. (It should be pointed out that this study will need to be repeated for the proposed use on cotton.)

- The honeybee acute contact LD_{50} and the honeybee residue study on foliage are not needed to support in-furrow applications to corn. However, the studies will be needed to support foliar groundspray and aerial application of fipronil. To date, the agency has only received a honeybee residue study on foliage (MRID #: 448841-01). The final report of this study is currently under review. It is assumed that the acute contact studies have been conducted because previous label warnings have advised that fipronil is highly toxic to honeybees.

- The registrant proposed the use of double row spacing for corn with a minimum row space of 15 inches. The minimum row space in the proposed labels for conditional registrations is 30 inches. The 15 inch row spacing will essentially double the amount applied on a per acre basis and will consequently double the exposure and risk in aquatic ecosystems.

Summary of Risk Conclusions

The risk assessment indicates that in-furrow use of fipronil, formulated as REGENT 1.5G, 80WG and 4SC, on corn is not likely to pose risk to gallinaceous birds (*i.e.*, bobwhite quail and pheasant) from ingestion of exposed granular fipronil. In addition, the high toxicity of fipronil and its degradates, compared to estimates of surface water concentrations from runoff, suggest toxicological risks to aquatic invertebrates. Fipronil and its degradates did not exceed acute toxic levels of concern for small mammal species or freshwater fish. Fipronil degrades to form metabolites of potential toxicological concern (MB46136, MB46513, and MB45950). The MB 46513 degradate is twice as toxic to birds and aquatic invertebrates as the parent. The other metabolites are assumed to be equally toxic as parent fipronil because they contain the same toxic moiety (CF_3-) as fipronil. The environmental fate data indicate that fipronil and its degradates have a moderate soil sorption affinity and moderate to high persistence in terrestrial and aquatic environments. Because fipronil residues exhibit a high environmental persistence, there is a high potential for accumulation in terrestrial and aquatic environments. Accumulation of fipronil residues (particularly fipronil degradates) is likely to result in long-term exposure. In-furrow application of fipronil, however, is expected to limit exposure, which is expected to reduce direct exposure to fipronil granules and to reduce the potential for fipronil movement in runoff waters. Double row cropping using the 4SC formulation is expected to double the amount of product applied on a per acre basis, but will not effect the terrestrial risk quotients. However, the exposure and risk quotients will double in aquatic ecosystems.

Finally, it should also be mentioned that EFED recently received data that indicates that freshwater chironomids are about three orders of magnitude more sensitive than the standard EPA test species, *Daphnia magna*. The chironomid LC_{50} is 0.43 µg/L while the Daphnid LC_{50} is 190 µg/L for the parent. The resulting risk quotients ranging from 0.67 to 1.35 now exceeds the acute level of concern for the parent. The RQs ranging from 6.5 to 15.7 also exceed the chronic levels of concern for the parent. The proposed labels correctly state that fipronil is toxic to "other aquatic and estuarine invertebrates," but with this new information it might be more appropriate to state that fipronil "is toxic to birds, fish, and aquatic invertebrates."

Recommendations for Label Revisions and Mitigation

Recommended mitigation options for in furrow use of fipronil are (1) restricted use classification and (2) label advisories. The registrant has volunteered to delete T-Band application methods from this proposed use to further mitigate risks to avian species.

Fipronil meets the criteria for classification as a **Restricted Use Pesticide** with regard to risks to aquatic invertebrates (40 CFR 152.170 (c)(1)(iii)). EFED therefore recommends that fipronil be classified as a Restricted Use Pesticide.

> Labels currently proposed contain language which is not consistent among products. EFED recommends that the label advisories for the environmental hazards statement for REGENT 1.5G, 3G, 80WG and 4SC use on corn should be consistent and include:
>
> This pesticide is toxic to birds, fish, and aquatic invertebrates. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Runoff from treated areas may be hazardous to aquatic organisms in neighboring areas. Cover, incorporate or clean up granules that are spilled. Do not contaminate water when disposing of equipment washwater or rinsate.
>
> Because of EFED's concern for estuarine organisms and because of the potential for accumulation of toxic residues in surface water receiving runoff from treated fields, EFED also recommends that the following precautions be incorporated into label language:
>
>> Observe the following precautions when applying in the vicinity of aquatic areas:
>>
>> Do not apply within 20 yards of lakes, reservoirs, rivers, permanent streams, marshes, natural ponds, estuaries, commercial aquaculture facilities, or other bodies of water that convey water to these areas.
>>
>> Protection of aquatic areas may be enhanced by maintaining all or a portion of this buffer in vegetative cover.
>
> Environmental fate data suggest that fipronil and particularly its degradates are persistent in the environment. PRZM/EXAMS modeling incorporating these data indicate that under the proposed application to corn, fipronil and its degradates have the potential to accumulate in soil and surface water over multiple consecutive years of application. This can result in concentrations exceeding those estimated for the first year of application. Although these predictions are not highly refined, they do suggest that risks to aquatic organisms may increase over multiple consecutive years of application.
> **Because of persistence and possible accumulation of residues, EFED recommends that labels for all fipronil products registered for use on corn indicate that fipronil should not be applied to the same field in consecutive years.** Alternating years of

application may provide sufficient time for degradative processes to reduce the potential for residue accumulation in the environment.

Endangered Species Statement

The Agency's level of concern for endangered and threatened aquatic invertebrates is exceeded for the proposed use of fipronil and its degradates on in-furrow application to corn. The registrant must provide information on the proximity of Federally listed aquatic invertebrates to the proposed use sites. This requirement may be satisfied in one of three ways: 1) having membership in the FIFRA Endangered Species Task Force (Pesticide Registration [PR] Notice 2000-2); 2) citing FIFRA Endangered Species Task Force data; or 3) independently producing these data, provided the information is of sufficient quality to meet FIFRA requirements. The information will be used by the OPP Endangered Species Protection Program to develop recommendations to avoid adverse effects to listed species.

Fipronil
Environmental Fate and Ecological Effects Assessment and Characterization for an Unconditional Registration of In-Furrow Applications to Corn

I. EXECUTIVE SUMMARY

The available fate and toxicity data for fipronil and its major degradates suggest that these compounds are highly toxic and persistent. Fipronil use on corn is limited to in-furrow applications, and risk is therefore, considerably reduced for terrestrial and aquatic species. However, the high persistence of fipronil degradation products is expected to contribute to residue accumulation in terrestrial and aquatic environments from successive yearly applications.

EFED calculated aquatic risk quotients for three in-furrow scenarios and considered both single row cropping (30 inch row space) and double row cropping (15 inch row space). The first scenario considered a combination of exposure of seed treated corn and in-furrow applications while the second scenario considered only in-furrow applications of non-treated corn seed. The last scenario considered treated corn seed only. All scenarios indicated RQ exceedances for the parent fipronil for freshwater and marine invertebrates for the parent fipronil for the first and second scenarios and restricted use and endangered species LOCs exceedances for marine invertebrates. These exceedances applied to both single and double row cropping. Chronic risk LOCs for the parent and the MB 46136 degradate were exceeded for the first and second scenarios for marine invertebrates by RQs ranging from 1.2 to 69 . Chronic risk for the parent were exceeded for the first and second scenarios for freshwater invertebrates by RQs ranging from 6.95 to 15.7. The seed treatment only scenario chronic risk LOCs were exceeded for the parent only for marine invertebrates and RQs ranged from 3.96 to 7.92. A complete list of aquatic LOC exceedances are presented in Tables 8, 9, and 10. The terrestrial risk remained unchanged since risk quotients were based on the treated area only at the same application rates. However, the RQs for the granular products have been revised due to some calculation errors.

II. INTRODUCTION

Chemical Name: Fipronil: 5-amino-1-(2,6-dichloro-4-(trifluoromethyl)phenyl)-4-((1,R,S)-(trifluoromethyl) sulfinyl)-1-H-pyrazole-3-carbonitrile

Chemical Type: Phenylpyrazole insecticide
CAS #: 120068-37-3
PC Code: 129121
Product Trade Names: Regent 80 WG, Regent 1.5G, and Regent 4SC Insecticides.

Mode of Action

According to the manufacture's data, fipronil affects the gamma-aminobutyric acid neurotransmission system by interfering with the passage of chloride . In addition, research data indicate that fipronil displays a higher potency in the insect GABA chloride channel than in the vertebrate GABA chloride channel which may indicate selective toxicity (Hainzl and Casida 1996).

Use Characterization for Corn Use Pesticides

According to Agricultural Statistics, 1994 (USDA) over 73 million acres of corn were planted in 1993 in 47 states (Alaska, Hawaii, Rhode Island excluded). Seed corn is also produced in Hawaii to increase breeder lines, but the acreage for this purpose is not quantified by the available data. Much of the corn belt includes ecologically sensitive ecosystems. A majority of the corn acreage (70%) is found in the following 13 states; Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, Kansas, Nebraska, Colorado, North Dakota, and South Dakota. Another 15% is grown in the southeastern states. A significant portion of the corn acreage occurs in such wildlife rich areas as the Prairie Pothole region, the Sandhills lake region of Nebraska and the playa lakes areas in the southwest. Many corn growth areas are used by waterfowl and shorebirds as breeding, feeding and migratory resting grounds, and they support a significant proportion of the total population of these birds. A number of freshwater habitat types are potentially exposed to varying levels of pesticide residues from runoff. Corn is also grown in many coastal counties. Off-site movement of chemicals applied to cornfields in these counties may enter estuarine areas which support important marine fishery resources and wildlife communities.

Target Organisms

The target organisms for corn uses of fipronil include northern corn rootworm larvae, southern corn rootworm larvae, Mexican rootworm larvae, wireworms, seedcorn maggots, seedcorn beetles, billbugs, chinch bugs, grubs, and thrips.

Formulation Information

REGENT 1.5G is a granular dispersible formulation, applied by either *T-Band or In-Furrow application methods.

*Active Ingredient:
5-amino-1-(2,6-dichloro-4-(trifluoromethyl)phenyl)-4-((1,R,S)-(trifluoromethyl)sulfinyl)-1-H-pyrazole-3-carbonitrile.......................................1.5%
Inert Ingredients...98.5%

* The registrant has volunteered to delete T-Band application methods from this proposed 1.5G use on corn in order to further mitigate risks to avian species.

REGENT 80 WG is a dry powder flowable water dispersable formulation, applied by either foliar spray * or ground spray methods depending on the crop use.

**Active Ingredient:
Fipronil..80%
Inert Ingredients.............................20%
*- Foliar spray does not pertain to corn use.
**Contains 0.833 pounds of active ingredient per pound of product.

Regent 4SC is a flowable concentrate. It is applied into the furrow as a solid stream after dissolving in water or liquid fertilizer.

Active Ingredient: Fipronil............................40%
Inert Ingredients...60%

ICON 6.2 is a flowable suspension. It is applied to corn seed at a maximum rate of 0.1 lb ai/100 lb. seed

Active Ingredient: Fipronil............................56%
Inert Ingredients...44%

Application Methods, Directions, and Rates

Application Timing
80 WG: Make one in furrow application of 0.13 lb ai/A at planting time only.

1.5G: A single application of 0.13 lb ai/A is made at planting only.

4SC: One in-furrow application of 0.13 lb ai/A at planting only. The registrant is also proposing to amend the Regent 4SC label to permit narrow row spacing (from 30 inches between rows to 15 inches between rows. The application rate will double the amount on a per acre basis to 0.26 lb ai/A on a 15 inch row space.
(More detailed information regarding label instructions is included as an addendum to this review)

ICON 6.2: Applied to corn seed at a maximum rate of 0.1 lb ai/100 lb. seed

III. INTEGRATED ENVIRONMENTAL RISK CHARACTERIZATION

Fipronil is moderately persistent to persistent ($t_{1/2}$= 128 to 300 days) and relatively immobile (mean K_{oc} 727 mL/g) in terrestrial environments. Major routes of dissipation appear to be dependant on photodegradation in water, microbially-mediated degradation, and soil binding. Fipronil degrades to form MB46136 and RPA 200766 in aerobic soil metabolism studies. MB46513 is a major degradate in photolysis studies. MB45950 appears to be predominantly formed under low oxygen conditions from microbial-mediated processes. These degradates appear to be persistent and relatively immobile in terrestrial and aquatic environments. Field dissipation studies confirm the persistence and relative immobility of fipronil and its degradates.

The ecological and drinking water assessments were conducted to assess the impact of single and double in-furrow uses, seed treatment, and combinations therein on ground and surface water quality. Drinking water and aquatic concentrations for fipronil and its degradates are based solely on ground and surface water models.

The water modeling was conducted using PRZM-EXAMS predicted concentrations for single row in-furrow use as reference concentrations. Pesticide concentrations for the double row spacing, seed treatment, and combinations therein were estimated through proportional adjustment of concentrations from single furrow applications. Additionally, the percent cropped area (PAC) factor was not used as a refinement for the drinking water assessment because multiple registered fipronil uses such as rice, fire ants, and termiticide are not considered in the development of PCA factors.

Because of the high persistence of fipronil degradation products in terrestrial and aquatic environments coupled with the lack of flow-through in the standard farm pond, fipronil degradation products in aquatic environments accumulated in water and sediments. This accumulation limits probabilistic concentration estimates because of temporal dependence in water concentrations.

The PRZM/EXAM modeling on the Southern Mississippi Uplands corn site is considered a very conservative runoff scenario because of the soil type (presence of a fragipan) and high rainfall conditions. Uncertainties in the surface water modeling are predominately associated with persistence of fipronil degradates in terrestrial and aquatic environments. Other uncertainties are associated with the formation efficiency of fipronil degradation products. Formation efficiencies were modeled according to the maximum percent formation observed in aerobic soil metabolism studies. Although higher degradate formation efficiencies were observed for MB46513 and MB45950 in other laboratory studies (photodegradation in water and anaerobic aquatic), these degradation pathways are not expected to be important in the corn root zone.

Because fipronil and its metabolites exhibit persistence and lower sorption affinity on coarse textured soils with low organic matter content, it possible that fipronil and it metabolites can move into shallow ground water on vulnerable sites. Moderate to high runoff areas in the major corn growing region (eastern two-thirds of the United States) are located in Ohio, southern Iowa and Illinois, and eastern Indiana, and the Gulf Coast of Texas. These have been identified as high runoff areas because of the high occurrence of Hydrologic Group C and D soils. It is important to note that runoff potential may also be affected by site specific management practices. Several highly vulnerable areas for shallow ground water have been identified as the coastal plains of Georgia, South Carolina, and North Carolina; eastern shore region of Lake Ontario; and the Delmarva Peninsula. Because several of these vulnerable areas are adjacent to estuarine environments, highly sensitive estuarine ecosystems may be potentially exposed to fipronil residues through surface water runoff or ground-surface water interactions.

Risks to Avian and Mammalian Receptors via Exposure to Fipronil in Granules

The terrestrial exposure for avian species is likely to be dependent on the in-furrow incorporation efficiency, granular dispersion processes, application timing, and the environmental persistence of fipronil in soil. In general, avian exposure is expected to be greatest from direct ingestion of inadvertently exposed granules. However, the incorporation of granules into soil following applications of the REGENT formulations to corn is expected to mitigate dietary exposure to some extent. Actual granules, which are a point of major concern for avian safety, should disperse into the soil upon contact with moisture. The dispersion of the granule will likely be controlled by diffusion gradients from the granule surface. Therefore, the concentration of residues in soil are expected to be less uniform than with other formulations.

Granular exposures to fipronil for gallinaceous birds (e.g., quail, partridge, and pheasant) from in-furrow and T-band uses of granular formulations on corn do not exceed any levels of concern, and some songbird and waterfowl species appear to be less sensitive than gallinaceous birds. Therefore, these birds are not felt to be at risk from in-furrow use of fipronil on corn. This risk assessment is based on single-dose oral toxicity studies with 6 species and dietary studies with 2 species. The potential impacts to avian species could be reductions in sensitive bird species populations (particularly gallinaceous species) in agricultural areas from oral ingestion of exposed granules, unearthed granules, and/or contaminated soils or soil organisms ingested through foraging activity. If acute impacts to bird populations from fipronil use do occur, they would be expected to concentrate during early spring months when corn is generally planted. The most sensitive avian species group tested for oral acute toxicity (quail, pheasant, and partridge) and dietary acute toxicity(quail) are also species commonly associated with agricultural production areas throughout the U.S. They are non-migratory and therefore potentially exposed throughout the growing season. Quail and other related species generally feed on seeds and insects which they often uncover by scratching the soil surface. There may be additional concerns regarding effects on a variety of migratory species potentially exposed if fipronil is applied with fall corn plantings. It is important to note that fipronil use on corn is restricted to a single at-plant application per season, regardless of when the crop is planted.

The assessment of risk to avian receptors from granular fipronil is based on ingestion of granules, the resultant risk quotients do not account for any exposure to fipronil degradates. It is anticipated that degradate residues from granular applications of fipronil would not be greater than encountered with in-furrow spray applications. Therefore, the potential for degradate risks to avian receptors for granular fipronil applications are not likely to be any greater than those estimated for in-furrow spray applications.

The absence of an EFED methodology for assessing risks to small mammals from ingestion of pesticides in granular formulation represents a considerable source of uncertainty to this risk assessment. Exposures of small mammals to granules not incorporated in soil cannot be quantified. The lack of quantified exposures via this route precludes assessment of risks to small mammals.

Risks to Avian and Mammalian Receptors via Exposure to Fipronil and Degradates in Soil and Soil Invertebrates (In-Furrow Spray)

Fipronil application by in-furrow spray will result in direct contact of the compound with soil particles. Because fipronil and it degradates exhibit persistence in laboratory and field dissipation studies, fipronil exposure may occur through ingestion of soil particles or soil invertebrates which have been coated by fipronil when applied as an in furrow spray. Several factors will control the concentrations of fipronil in soil and biotic compartments (e.g., soil invertebrate tissues) including aerobic soil metabolism, partitioning between soil and water, and volatilization. These properties were factored into the exposure assessment using an equilibrium partitioning (fugacity) model to estimate concentrations in soil and soil invertebrates. Because fipronil is applied during sensitive nesting and fledgling life stages of birds, the exposure potential will likely be higher. Quail species often forage in fields along with their young in the late spring or late summer (2nd clutch). Younger birds, therefore, are likely to be exposed to fipronil. Though data regarding sensitivity of younger gallinaceous species to fipronil is not available, it is expected that they may be more sensitive to an oral dosage than adult sized birds.

The actual physical exposure area in a given corn application site receiving in furrow spray nozzle application of fipronil is reduced to areas within or surrounding the actual furrow. However, this furrow area will contain a highly concentrated residue level since the per acre application rate is concentrated in the furrows. The incorporation of liquid sprays into soil can be expected to mitigate dietary exposure to some extent. Dietary exposures are expected to be at a maximum for bird and mammalian species that disturb or uncover soils in search of soil invertebrates. The most sensitive avian species for which toxicological data are available (quail, partridge, and the pheasant) are known to display this type of activity. It should also be mentioned that the proposed decreasing of the row spacing (double row cropping) will double the amount of exposure on a per acre basis, and the likelihood that birds and small mammals will be exposed to the residues is twice as great.

Comparisons of short-term dietary exposures to fipronil and its degradates to acute toxicological data suggest that the parent compound and degradates from in-furrow spray applications do not pose an acute risk to birds and mammals. However, the exposure estimates for avian and mammalian species do not include any exposure to fipronil or its degradates accumulated from soil through ingestion of vegetation. As vegetation may be an important dietary component in many avian and small mammal species, disregarding this exposure pathway represents a potential underestimation of risk.

Chronic dietary exposures for in-furrow spray applications of fipronil and associated degradates are based on average soil concentrations for the first 20-week period following year 1 of application. The models for these chronic exposure estimates conservatively assume that receptor organisms feed only in treated fields and consequently receive all incidental soil invertebrate prey exposure from the treated fields. The dietary exposure models assumed a depth-integrated concentration of fipronil or degradate at 15 cm as the appropriate interval for soil invertebrate exposure. In addition, soil ingestion of these compounds was assumed to occur with soils at a 1 cm depth; fipronil and degradate concentrations at this depth were factored into models of the incidental soil ingestion exposure route. Uncertainties associated with the percentage of prey and foraging occurring in treated fields cannot be quantified as many site specific factors (e.g., field size and geographical distribution) are likely to greatly influence the frequency and intensity of the use of treated corn fields as habitat.

The chronic dietary in-furrow spray assessment does not account for the potential for fipronil residue accumulation, particularly degradates, in soils from long-term repeated fipronil use. This would suggest that avian and mammalian exposure to fipronil and its degradates, and associated toxicological risk is underestimated, with respect to application years following the first year. Assuming that the degradates are of a high persistence ($t_{1/2}$ ca. 700 days) there remains the potential that repeated long-term use of fipronil would result in degradate soil concentrations exceeding first-year estimates. However, the degree to which the model underestimates exposure is uncertain as the model employed to assess accumulation over subsequent treatment years assumed in-furrow application to a fixed series of row locations in a given field. It is expected that actual furrow locations across a field will vary from year to year and therefore actual repetitive year accumulations may be lower than estimated by the existing model. Another route of oral exposure not accounted for in the dietary exposure assessment is ingestion of fipronil dissolved in stormwater puddles on treated fields.

Because no clear chronic or reproductive effects profile (establishment of discrete NOEC and LOEC) has been determined for bobwhite or equally sensitive species at the expected environmental concentrations, potential chronic effects cannot be dismissed at this time. The available NOEC established at the highest dose tested (10 ppm) suggests that chronic hazard, if any gallinaceous birds may occur quite near the acute dietary thresholds suggested by the acute LC_{50} of 48 ppm. However, chronic test concentrations never exceeded 10 ppm. The LOEC for most sensitive bird species is uncertain at this time. Additionally, since fipronil metabolites (MB46136 and MB45950) contain the toxicological moiety (CF_3-) of parent fipronil and long-term exposure is anticipated because of high persistence in terrestrial environments, avian dietary studies are needed for MB46136 and MB45950.

A final uncertainty associated with dietary risks of fipronil and its degradates is the consideration of possible additive effects of exposure to combinations of the compounds. This risk assessment assumes that biologically active structural moieties in common between fipronil and degradates have similar toxicological potency. The logical extension to this structure/activity assumption is that compounds with common biologically active moieties may produce additive effects in organisms exposed to fipronil and toxic degradates. However, the magnitude of the effect of considering the combined toxic effects of fipronil and degradates cannot be determined at the present time because of incomplete comparative toxicological data.

Risks to Aquatic Organisms

Based on the data presented for mysid shrimp, the most sensitive species tested, there is a high risk for chronic life-stage (reproductive) effects and moderate acute risk to estuarine invertebrates from use of fipronil use on corn. Because fipronil is extremely toxic to estuarine invertebrates and refined surface water modeling indicates surface water concentrations in excess of toxicity thresholds, a new mysid full life cycle (72-4) study with MB 46136 is needed to assess chronic effects on non-target aquatic invertebrates.

Recent data also indicate that fipronil and its degradates also show a great sensitivity to certain freshwater invertebrates. Tests show that chironomid LC_{50} is about 440 times more toxic than the daphnid. RQs now exceed acute levels of concern for freshwater invertebrates for in-furrow corn applications. Further testing of freshwater invertebrate species such as mayflies, stoneflies, and caddisflies would do much to alleviate the uncertainty of freshwater invertebrates.

Predicted PRZM-EXAMS EEC levels exceed the chronic levels of concern for freshwater and marine invertebrate species. Exposure of breeding fish populations may be more likely in early spring months for migratory fish species. The timing of fipronil applications would appear to correlate with these sensitive life stages. Also, since fipronil and its metabolites contain the same toxic moiety (CF_3-) and are persistent.

Aquatic exposure modeling for the fipronil degradates MB 46136 and MB 45950 indicates that EECs are not high enough to cause acute or chronic effects to fish. PRZM-EXAMS modeling indicates that fipronil degradates can accumulate in surface waters from corn use. Double cropping scenarios double the aquatic exposure and consequent risk to all freshwater species.

Uncertainties in the aquatic risk assessment are associated with the applicability of the GENEEC and PRZM/EXAMS model scenarios and the potential accumulation of fipronil degradates in estuarine environments. Estuarine environments are rarely isolated watersheds such as depicted by GENEEC and PRZM-EXAM modeling. Therefore, predicted EECs from PRZM-EXAMs are likely to be conservative because tidal dilution effects are not considered.

IV. ENVIRONMENTAL FATE AND TRANSPORT ASSESSMENT

Summary

Fipronil dissipation appears to be dependent on photodegradation in water, microbially mediated degradation, and soil binding. Data indicate that fipronil is relatively persistent and immobile in terrestrial environments. In aquatic environments, a determination of the environmental behavior of fipronil is more tentative because soil and aquatic metabolism studies provide contradictory data on fipronil persistence to microbially mediated degradative processes. Photolysis is expected to be a major factor in controlling fipronil dissipation in aquatic environments. Fipronil degrades to form persistent and immobile degradates. These degradates are considered in the HED dietary tolerance expression for fipronil Since fipronil and its degradates have a moderate to high sorption affinity to organic carbon, it is likely sorption on soil organic matter will limit fipronil residue movement into ground and surface waters. However, fipronil residue may have the potential to move in very vulnerable soils (e.g., coarse-textured soils with low organic matter content). In-furrow fipronil applications are expected to limit runoff potential. Foliar applications of fipronil are expected to encourage spray drift as a route of dissipation.

Abiotic Degradation

The chemical degradation of fipronil appears to be dependent predominately on photodegradation in water and, to a lesser extent, on alkaline-catalyzed hydrolysis. Fipronil is stable ($t_{1/2}$ > 30 days) in pH 5 and pH 7 buffer solution and hydrolyzes slowly ($t_{1/2}$=28 days) in pH 9 buffer solution. The major hydrolysis degradate is RPA 200766 (5-amino-3-carbamoyl-1-(2,6-dichloro-4-trifluoromethylphenyl)-4-trifluoro-methanesulfinyl pyrazole. Photodegradation of fipronil is a major route of degradation (photodegradation in water half-life=3.63 hours) in aquatic environment. In contrast, fipronil photodegradation on soil surfaces (dark control corrected half-life=149 days) does not appear to a major degradation pathway. Major photolysis products of fipronil are MB 46513 (5-amino-3-cyano-1-(2,6-dichloro-4-trifluoromethyl-phenyl)-4-trifluoro-methylpyrazole 350, and RPA 104615 (5-amino-3-cyano-1-(2,6-dichloro-4-trifluoro methyl phenyl) pyrazole-4-sulfonic acid).

Biotic Degradation

Fipronil degradation in terrestrial and aquatic systems appears to be controlled by slow microbially-mediated processes. In aerobic mineral soil, fipronil is moderately persistent to persistent ($t_{1/2}$= 128 to 300 days). Major aerobic soil degradates (>10% of applied of fipronil) are RPA 200766 and MB 46136 (5-amino-1-(2,6-dichloro-4-trifluoro methylphenyl)-3-cyano-4-trifluoromethyl-sulphonyl-pyrazole). Minor degradates (<10% of applied fipronil) are MB 45950 (5-amino-1-(2,6-dichloro-4-trifluoromethylphenyl)-3-cyano-4-trifluoro-methyl-thio-pyrazole) and MB46513. These degradation products are not unique soil metabolism degradation products. Fipronil degraded ($t_{1/2}$=14.5 days to 35 days) under stratified redox aquatic/sediment systems. Fipronil also is moderately persistent (anaerobic aquatic $t_{1/2}$ = 116-130 days) in anoxic aquatic environments. Major anaerobic aquatic degradates are MB 45950 and RPA 200766.

Supplemental aerobic aquatic metabolism data indicate that fipronil degradation ($t_{1/2}$=14 days) is rapid in aquatic environments with stratified redox potentials. These data contradict the longer fipronil persistence reported in anaerobic aquatic and aerobic soil studies.

Mobility

Fipronil has a moderate sorption affinity (K_f=4.19 to 20.69 mL/g; 1/n= 0.938 to 0.969; K_{oc}= 427 to 1248 mL/g) on five non-United States soils. Fipronil sorption appears to be lower (K_f< 5 mL/g) on coarse-textured soils with low organic matter contents. Desorption coefficients for fipronil ranged from 7.25 to 21.51 mL/g. These data suggest that fipronil sorption on soil is not a completely reversible process. Since the fipronil sorption affinity correlates with soil organic matter content, fipronil mobility may be adequately described using a K_{oc} partitioning model. Soil column leaching studies confirm the immobility of fipronil.

Environmental Fate of Fipronil Degradates

Conclusions regarding the environmental fate of fipronil degradates, except MB 46513, are more tentative because they are based on a preliminary review of interim data, not a formal evaluation of a fully documented study report. Since discernable decline patterns for the fipronil degradates were not observed in metabolism studies, the degradates are assumed to be persistent ($t_{1/2} \approx$700 days) to microbially mediated degradation in terrestrial and aquatic environments. However, the fipronil degradate, MB46136, rapidly photodegrades ($t_{1/2}$=7 days) in water. Radiolabelled MB 46513, applied at 0.1 µg/g, had an extrapolated half-life of 630 or 693 days in loamy sand soils when incubated aerobically in the dark at 25°C. The major metabolite of MB 46513 was RPA 105048 (5-amino-3-carbamoyl-1-(2,6-dichloro-4-trifluoromethylphenyl)-4-trifluoromethylsulfonyl pyrazone).

Fipronil degradation products have relatively low potential mobility because of a moderate to high sorption affinity to soil organic matter. Organic carbon partitioning coefficients for fipronil degradates can range from 1150 to 1498 mL/g for MB 46513, 1619 to 3521 mL/g for MB 45950, and 1448 to 6745 mL/g for MB 46136. The high sorption affinity of fipronil degradates is expected to limit movement into ground and surface water.

Soil Field Dissipation

Terrestrial field studies confirm observations of the relative persistence and immobility of fipronil residues in laboratory studies. Fipronil, formulated as a 1% granular, had half-lives of 1.1 to 1.5 months on bare ground in North Carolina (NC) and Florida (FL), 0.4 to 0.5 months on turf in NC and FL, and 3.4 to 7.3 months for in-furrow applications on field corn in California (CA), Nebraska (NE), NC, and Washington (WA). Fipronil, formulated as 80WG and applied foliar spray at 0.3 lbs ai/A, had a field dissipation half-life of 159 days on a cotton site in California, 30.2 days on cotton site in Washington, and 192 days on a potato site in Washington.

The fipronil degradates MB 46136, MB45950, and RPA 200766 were detected in the field studies for in-furrow and turf uses. The degradate MB46513 was detected during field trails with the foliar spray. Fipronil residues were predominately detected in the 0 to 15 cm soil depth at all test sites. However, there was detection of fipronil, MB 45950, MB 46136 and RPA 200766 at a depth of 15 to 45 cm for in-furrow treatments on coarse sandy loam soil in Ephrata, Washington. Although the field dissipation half-life of individual residues was not reported, the half-life of combined fipronil residues (including fipronil, MB 46136, MB 46513, MB 45950, and RPA 200766) ranged from 9 to 16 months.

The bioconcentration factor for radiolabelled fipronil was 321X in whole fish, 164X in edible tissues, and 575X in non-edible tissues. Accumulated fipronil residues were eliminated (>96%) after a 14-day depuration period. Because fipronil exhibited a high depuration rate, fipronil is not expected to accumulate under flowing water conditions.

V. AQUATIC EXPOSURE and DRINKING WATER ASSESSMENT (*see Appendix A for detailed information*)

Modeling Parameters

The dissipation of fipronil in surface water should be dependent on photodegradation in water and, to a lesser extent, microbial-mediated. Since photolysis is a major route of degradation for fipronil, its dissipation is expected to be dependent on physical components of the water (*i.e.* sediment loading) which affect sunlight penetration. For example, fipronil is expected to degrade faster in clear, shallow water bodies than in murky and/or deeper waters. Since fipronil and its transformation products have moderate soil-water partitioning coefficients, binding to sediments may also be a route of dissipation.

The following data were used as input for the PRZM/EXAMS modeling of fipronil:

Parameter	Value	Source
Application rate	0.1456 kg/ha	REGENT 4SC
Soil K_{oc}	727 mL/g[1]	MRID 44039003
Aerobic soil half-life	128 days	MRID 42918663
Plotolysis Half-life	0.16 days	MRID 42918661
Hydrolysis pH 7	Stable	MRID 42194701
Aerobic Aquatic Half-life	33.7 days[2]	MRID 44661301, 44261909
Anaerobic Aquatic Half-life	33.7 days[2]	MRID 44661301, 44261909
Water solubility	2.4 mg/L	EFGWB one-liner

1- Mean Koc value
2-Represents the 90^{th} percentile of the mean

EFED also conducted surface water modeling for the individual degradates including MB 46513, MB 46136 and MB45950. Environmental fate properties of the fipronil degradates are shown in Table 1. The modeling was conducted assuming the maximum daily conversion efficiency for the compound was represented by the maximum percentage formed in the environmental fate laboratory studies. Degradate application was assumed to coincide with fipronil application. Because the fipronil degradates are formed through abiotic or biotic degradation pathways in soil and water, the degradates were assumed to have a 100% application efficiency on the soil surface. This approach for estimating degradate concentrations is expected to be conservative.

Table 1: Fate Properties of Fipronil Degradates

Fate Parameter	MB 46136	MB 46513	MB 45950
Mean Koc	4208 mL/g	1290 mL/g	2719 mL/g
Aerobic Soil Metabolism Half-life	700 days	660 days	700 days
Aqueous Photolysis Half-life	7 days	Stable	Stable
Hydrolysis Half-life	Stable	Stable	Stable
Aquatic Metabolism Half-lives	1400 days	1320 days	1400 days
Water Solubility	0.16 mg/L	0.95 mg/L	0.1 mg/L
Single Row Spacing Application Rate (kg a.i./ha)	0.0349	0.0014	0.0072
References	**RP# 201555 ACD/EAS/Im/255 Theissen 10/97**	MRID 44262831 44262830 **Theissen 10/97**	**RP 201578 Theissen 10/97**

PRZM (3.12 version) and EXAM (2.97.5) were used for Tier II simulations for in-furrow single row spaced corn. Fipronil and degradate water concentrations for the double row spacing and corn seed treatment were estimated through proportional adjustment of water concentration for application rate. Water concentrations for double row spacing were estimated at 100% (2X higher) of the single row spaced in-furrow use. Seed treatment alone and dual in-furrow/seed treatment use were estimated at 13%, and 113%, respectively, of the water concentrations for single and double row spaced corn. This approach was taken because fipronil use on corn is associated with in-furrow application techniques such as a seed treatment or in-furrow spray. The combination of in-furrow and seed treatment use of fipronil was modeled because the label does not restrict dual fipronil applications.

Fipronil residue concentrations, expressed as fipronil equivalents, are presented as individual concentrations and as cumulative fipronil residues. The cumulative residue approach assumes that fipronil and its degradation products have equal toxicity profiles.

Ecological Exposure Assessment

Tier II PRZM-EXAMS model simulation of a single row in-furrow application indicates the 1 in 10 year daily peak and 21 day average concentrations for fipronil are not likely to exceed 256.4 and 152.9 ng/L, respectively (Table 2). The proposed double row in-furrow application is predicted to double single row in-furrow estimated environmental concentrations. The 1 in 10 year daily peak and 21 day average concentrations for double row in-furrow applications are not likely to exceed 512.8 and 305.8 ng/L, respectively.

Table 2: Estimated Concentrations of Fipronil and its Degradation Products in the Standard Pond From Single and Double Row In-furrow Corn Cropping Systems (ppt or ng L^{-1})

	Peak		96 Hour Average		21 Day Average		60 Day Average	
	Single Row	Double Row[1]	Single Row	Double Row[1]	Single Row	Double Row[1]	Single Row	Double Row[1]
Fipronil	256.4	512.8	229.2	458.4	152.9	305.8	77.8	155.6
MB46513[2]	0.9	1.8	0.8	1.6	0.8	1.6	0.7	1.4
MB46136[2]	9.4	18.4	8.2	16.4	6.0	12	4.3	8.6
MB45950[2]	2.8	5.6	2.6	5.2	2.1	4.2	1.6	3.2

1-Double row spacing concentrations were estimated (2X) from single row in-furrow applications.
2-Indicates year to year autocorrelation prevented calculation of a 1 in 10 year concentration. Reported concentrations represent the concentrations in the first simulation year (1948).

The peak estimated environmental concentrations for seed treatment alone are not expected to exceed 33 ng/ L and 66 ng/L for single and double row spacing, respectively (Table 3). These estimated concentrations are based solely on application rate reductions for treated seed applications (0.017 lbs ai/A for single row spacing).

Table 3: Estimated Concentrations of Fipronil and its Degradation Products in the Standard Pond From Seed Treatment Alone with Single and Double Row Corn Cropping Systems (ppt or ng L^{-1})[1]

	Peak		96 Hour Average		21 Day Average		60 Day Average	
	Single Row	Double Row	Single Row	Double Row	Single Row	Double Row	Single Row	Double Row
Fipronil	33.3	66.6	29.7	59.4	19.8	39.6	10.1	20.2
MB46513[2]	0.1	0.2	0.1	0.2	0.1	0.2	0.09	0.1
MB46136[2]	1.2	2.4	1.0	2.0	0.7	1.4	0.5	1.0
MB45950[2]	0.3	0.6	0.3	0.6	0.2	0.4	0.2	0.4

1- Predicted concentrations were estimated from values in Table 2. These values are 13% of the in-furrow application rates (Table 1).
2-Indicates year to year autocorrelation prevented calculation of a 1 in 10 year concentration. Reported concentrations represent the concentrations in the first simulation year (1948).

The peak fipronil estimated environmental concentrations for a combined seed treatment and in-furrow use are not expected to exceed 289.7 ng/L and 579.4 ng/L for single and double row spacing, respectively (Table 4). These estimated concentrations are based solely on the cumulative application rate of in-furrow and seed treatments.

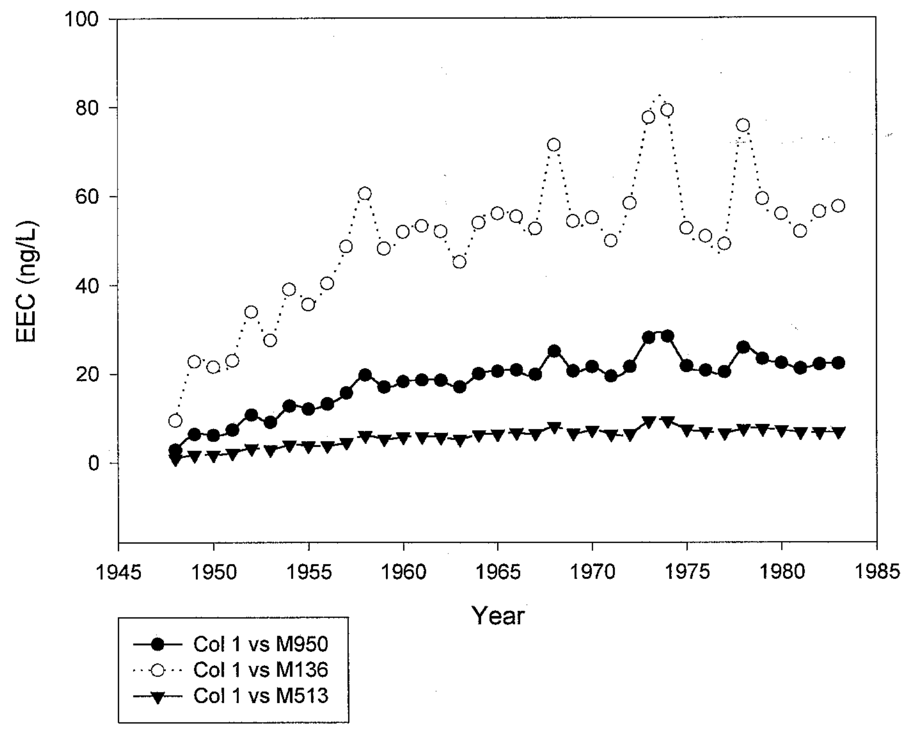
Table 4:Estimated Concentrations of Fipronil and its Degradation Products in the Standard Pond From Seed Treatment with In-furrow Fipronil Application Single and Double Row Corn Cropping Systems (ppt or ng L^{-1})[1]

	Peak		96 Hour Average		21 Day Average		60 Day Average	
	Single Row	Double Row	Single Row	Double Row	Single Row	Double Row	Single Row	Double Row
Fipronil	289.7	579.4	258.9	517.8	172.7	345.4	87.9	175.8
MB46513[2]	1.0	2.0	0.9	1.8	0.9	1.8	0.7	1.4
MB46136[2]	10.6	21.2	9.2	18.4	6.7	13.4	4.8	9.6
MB45950[2]	3.1	6.2	2.9	5.8	2.3	4.6	1.8	3.6

1- Predicted concentrations were estimated from values in Table 2. These values are 113% of the in-furrow application rates (Table 1).
2-Indicates year to year autocorrelation prevented calculation of a 1 in 10 year concentration. Reported concentrations represent the concentrations in the first simulation year (1948).

Tier II PRZM-EXAMS modeling for individual fipronil degradates indicated that residue accumulated in the MSPOND environment. This accumulation can be attributed to the high potential persistence of fipronil degradation products in aquatic environments. The accumulation for single in-furrow application of fipronil degradation products is show Figure 1. Double row spacing and combined in-furrow and seed treatment applications are expected to increase the accumulation proportional to the application rate.

Annual Accumulation of Fipronil Degradation Products in the MSPOND from a Single Row Spacing In-Furrow Corn Us



Drinking Water Assessment

Tier II PRZM-EXAMS modeling for single row spacing using the index reservoir indicates the 1 in 10 year daily peak (acute) and 90 day average (non-cancer chronic) drinking water concentrations for fipronil are not likely to exceed 630 and 158.5 ng/L, respectively (Table 5). The 1 in 10 year annual average concentration and 36 year annual average concentration are not likely to exceed 46.3 and 23 ng/L, respectively. The concentration of combined fipronil residues are not expected to exceed 757.4 ng/L for the 1 in 10 year daily peak, 237.4 µg/L for the 1 in 10 year 90 day average, 95.5 ng/L for the 1 in 10 year annual average, and 59.3. ng/L for the 36 year annual average.

The proposed double row spacing is expected to double the predicted drinking concentrations from the single row spacing. Based on an application rate adjustment of the in-furrow single row drinking water concentrations, the 1 in 10 year daily peak (acute) and 90 day average (non-cancer chronic) drinking water concentration for fipronil is not likely to exceed 1260.6 and 317 ng/L, respectively The 1 in 10 year annual average concentration and 36 year annual average concentration is not likely to exceed 92.6 and 46 ng/L, respectively.

EFED believes the most appropriate PRZM-EXAMS Tier II screening modeling approach is to assume no PCA correction because of the multiple registered uses of fipronil can coexist in same geographic area. For example, rice, corn, in addition to urban uses can possibly occur in parts of the Mississippi embayment area. Additionally, the PCA adjustment factors cannot account for the impact of urban use.

Table 5: Estimated Concentrations of Fipronil and its Degradation Products in the Index Reservoir from Single and Double Row In-furrow Corn Cropping Systems (ppt or ng L^{-1})

	Peak		90 Day Average		Annual Average		36 Year Annual Average	
	Single Row	**Double Row**	**Single Row**	**Double Row**	**Single Row**	**Double Row**	**Single Row**	**Double Row**
Fipronil	630.3	1260.6	158.5	317	46.3	92.6	23.0	46
MB 46513	6.2	12.4	4.0	8.0	2.2	4.4	1.4	2.8
MB 46136	97.9	195.8	59.7	119.4	37.7	75.4	28.1	56.2
MB 45950	23.0	46	15.2	30.4	9.3	18.6	6.8	13.6
Summed Residues[1]	757.4	1514.8	237.4	474.8	95.5	191	59.3	118.6

1-Double row spacing concentrations were estimated (2X) from single row in-furrow applications.

The proposed seed treatment for corn is expected to reduce estimated drinking water concentrations. These reductions assume fipronil treated seed and in-furrow uses are not used together in an agricultural management system. Based on an application rate adjustment of the in-furrow concentrations, the 1 in 10 year daily peak (acute) and 90 day average (non-cancer chronic) drinking water concentrations for single row spaced corn are not likely to exceed 81.9 and 20.6 ng/L, respectively (Table 6) The 1 in 10 year annual average concentration and 36 year annual average concentration are not likely to exceed 6 and 2.9 ng/L, respectively. The 1 in 10 year daily peak (acute) and 90 day average (non-cancer chronic) drinking water concentrations for double row spaced corn are not likely to exceed 163.8 and 41.2 ng/L, respectively The 1 in 10 year annual average concentration and 36 year annual average concentration are not likely to exceed 12 and 5.8 ng/L, respectively.

Table 6: Estimated Concentrations of Fipronil and its Degradation Products in the Index Reservoir From Seed Treatment Alone with Single and Double Row Corn Cropping Systems (ppt or ng L^{-1})[1]

	Peak		90 Day Average		Annual Average		36 Year Annual Average	
	Single Row	Double Row	Single Row	Double Row	Single Row	Double Row	Single Row	Double Row
Fipronil	81.9	163.8	20.6	41.2	6.0	12.0	2.9	5.8
MB46513[2]	0.8	1.6	0.5	1	0.2	0.4	0.1	0.2
MB46136[2]	12.7	25.4	7.7	15.4	4.9	9.8	3.6	7.2
MB45950[2]	2.9	5.8	1.9	3.8	1.2	2.4	0.8	1.6

1- Predicted concentrations were estimated from values in Table 5. This factor represents 13% of the in-furrow application rates (Table 5).
2-Indicates year to year autocorrelation prevented calculation of a 1 in 10 year concentration. Reported concentrations represent the concentrations in the first simulation year (1948).

The combination of seed treatment and in-furrow use is expected to be the highest estimated drinking water concentrations. This assessment assumes that fipronil treated seed and in-furrow fipronil uses are equally available for runoff. Based on an application rate adjustment of the in-furrow concentrations and seed treatment, the 1 in 10 year daily peak (acute) and 90 day average (non-cancer chronic) drinking water concentrations for seed treatment and single row spaced corn are not likely to exceed 711.9 and 179.1 ng/L, respectively (Table 7). The 1 in 10 year annual average fipronil concentration and 36 year annual average concentration are not likely to exceed 52.3 and 25.9 ng/L, respectively. The 1 in 10 year daily peak (acute) and 90 day average (non-cancer chronic) drinking water concentrations for double row spaced corn are not likely to exceed 1423.8 and 358.2 ng/L, respectively The 1 in 10 year annual average concentration and 36 year annual average concentration are not likely to exceed 104.6 and 51.8 ng/L, respectively.

Table 7: Estimated Concentrations of Fipronil and its Degradation Products in the Index Reservoir From Seed Treatment with In-furrow Fipronil Application Single and Double Row Corn Cropping Systems (ppt or ng L^{-1})[1]

	Peak		90 Day Average		Annual Average		36 Year Annual Average	
	Single Row	**Double Row**	**Single Row**	**Double Row**	**Single Row**	**Double Row**	**Single Row**	**Double Row**
Fipronil	711.9	1423.8	179.1	358.2	52.3	104.6	25.9	51.8
MB46513[2]	7.0	14.0	4.5	9.0	2.4	4.8	1.5	3.0
MB46136[2]	110.6	221.2	67.4	134.8	85.2	170.4	31.7	63.4
MB45950[2]	25.9	51.8	17.1	34.2	21.0	42.0	7.6	15.2

1- Predicted concentrations were estimated from values in Table 5. This factor represents 113% of the in-furrow application rates (Table 5).

Uncertainties in Modeling

Because the fipronil use on corn is associated with in-furrow application techniques such as a seed treatment or in-furrow spray, the water modeling for double row spacing and seed treatments was conducted using application rate proportional adjustment of water concentrations for in-furrow single spaced application. This modeling approach assumes application rate is the only factor controlling environmental fate processes for fipronil and degradation products. It does not account for differential fate processes of fipronil and degradation products for seed treatment and in-furrow uses. It also assumes that 100% of the fipronil on corn seed is available for runoff. This approach is expected to provide a conservative estimate of fipronil concentrations in water.

Although OPP policy is to use the default PCA when there are no PCA's available for crops, EFED believes the most appropriate screening approach is to assume no PCA because it accounts for the multiple registered crop uses of fipronil and the urban/turf uses. Although available monitoring data for rice uses of fipronil is not representative of surface waters used as drinking water, it indicates maximum fipronil concentrations ranged from 2.118 to 8.41 ug/L. These concentrations are higher than the daily peak concentration predicted for the proposed uses on corn. However, the various uses of fipronil are expected to vary in potential fipronil loading into surface water. EFED believes the proposed corn use is expected to have the lowest impact on fipronil residue loading into surface water used as drinking water because of in furrow application techniques.

Another uncertainty is the half-life of fipronil and its degradates in aerobic aquatic environments. The aerobic aquatic metabolism data (MRID 44261909) indicate that fipronil has a half-life of 14.5 days in aerobic aquatic environments. These data appear to contradict the persistence of fipronil ($t_{1/2}$=128 to 308 days) in aerobic soil metabolism studies. The registrant has submitted additional aerobic aquatic data showing first-order half-life for fipronil was 16 days for Ongar and

35.62 days for Manningtree sediment/water systems (RPA Document 201604). Based on the available aerobic aquatic metabolism data, the 90th percentile aerobic aquatic half-life for fipronil is 33.7 days. The drinking water assessment was conducted using the 90th percentile aerobic aquatic metabolism half-life. It's important to note that the aerobic aquatic metabolism studies were conducted under stratified redox conditions which lead to the formation of MB45950, a toxic degradation product. This compound was predominately associated with the sediment phase. Similar formation patterns were not observed in the aerobic soil metabolism studies (MRID 42928663). The PRZM-EXAMS modeling did not account for the conversion of fipronil to MB45950 in the index reservoir. This approach is not expected to alter the drinking water assessment because MB45950 partitioning in the reservoir was predominantly associated with the sediment phase rather than the dissolved phase.

Tier II modeling indicates the individual residues contribute substantially to the summed residue concentration of fipronil. Both MB 46513 and MB 46136 contribute to approximately two-thirds (68%) of the fipronil residues in drinking water. The concentration of MB 46513 is expected to be conservative because its application rate is base on a maximum degradate formation efficiency (1%) from aerobic soil metabolism study (MRID 42918663). Lower concentrations of MB 46513 have been detected in other environmental fate studies. MB 45950 had low concentrations in all environmental fate studies except for the aquatic metabolism studies. The highest conversion efficiency of MB45950 was not considered because it is associated with anoxic (anaerobic environments). Therefore, the summation of degradation products is not expected be conservative because the maximum degradate conversion efficiency was not assumed to occur under the same environmental conditions.

Surface Water Monitoring

Surface water monitoring data for fipronil has been conducted to assess impacts of fipronil use on rice to surface water quality. This monitoring was triggered because fipronil has been suspected of causing adverse effects on crayfish in Louisiana. Although rice cultural practices and site hydrology are different than corn, these crops can be commonly grown in the same regions of the country (*e.g.*, Mississippi Embayment). Therefore, the monitoring data from rice culture uses of fipronil provide an indication of the pre-existing concentrations of fipronil in ambient surface waters in the southern Louisiana rice growing region.

The monitoring is discussed in Appendix I.

Ground Water

Based on the SCI-GROW model, acute and chronic drinking water concentrations in shallow ground water from double row in-furrow uses with treated seed are not likely to exceed 0.0236 μg/L for parent fipronil, 0.0009 μg/L for MB 46136, 0.0002 μg/L for MB 46513, and 0.0003 μg/L for MB 45950. These concentrations are expected to be the highest fipronil residue concentrations for fipronil corn use uses.

VI. Aquatic Risk Assessment

Likelihood of Exposure

Fipronil displays high toxicity to most aquatic organisms tested to date. The large multi-state area that may be encompassed by this use pattern will undoubtedly include sites which are adjacent to irrigation canals, streams, ponds, rivers, lakes and estuarine habitats. Thus, the aquatic species diversity which is potentially at risk to exposure from runoff is large.

Aquatic Risk Quotients for Granular and Ground Spray Methods of Application

The acute and chronic risk quotients (RQ) for freshwater and estuarine organisms based on technical fipronil are summarized in Tables 14, 15, and 16 below. The application scenarios are based on a single 10 ha application with a 1 inch soil incorporation depth at 0.13 lbs ai/acre for single row cropping to 0.26 lb ai/acre for double row cropping with incorporation to 1 inch depth. Table 8 presents the RQs resulting from the combination exposure of seed treated corn and in-furrow applications. Table 9 shows the RQs resulting from only in-furrow applications while Table 10 indicates the results from only seed treated corn exposure. All the tables show RQs from both single row and double row cropping.

Table 8. Acute and Chronic Risk Quotients for Freshwater and Estuarine Organisms for Fipronil and its Degradation Products in the Standard Pond From Seed Treatment with In-furrow Fipronil Application Single and Double Row Corn Cropping Systems (ppb or µg L^{-1})[1]

Most Sensitive Species Group Tested	Levels of Concern Acute (LC_{50}) Chronic (NOEC) (µg/L)	Peak EEC* (µg/L)		Chronic EEC[1] (µg/L)		Maximum Acute RQ's		Maximum Chronic RQ'S	
		Single Row	Double Row	Single Row	Double Row	Single Row	Double Row	Single Row	Double Row
Fipronil									
Freshwater Fish 429186-24	LC50=83 NOEC=6.6 LOEC=15 (parent)	0.2897	0.5794	0.0879	0.1758	0.0035	0.007	0.013	0.026
Freshwater Invertebrate (Stevens et. al. 1998)	EC50=0.43 NOEC=0.022[8] LOEC=0.045[8] (parent)	0.2897	0.5794	0.1727	0.3454	0.673*	1.347*	7.85****	15.7** **
Estuarine Crustacea 432797-01	LC50=0.14 NOEC<0.005 LOEC=0.005 (parent)	0.2897	0.5794	0.1727	0.3454	2.069*	4.138*	>34.54* ***	>69.08 ****
Estuarine Mollusc 432917-01	EC50=770 (parent)	0.2897	0.5794	0.1727	0.3454	0.0004	0.0007	No Tox Data	No Tox Data
Estuarine Fish 432917-02	LC50=130	0.2897	0.5794	0.0879	0.1758	0.0022	0.0044	No Tox Data	No Tox Data
Degradate MB46136									
Freshwater Invertebrate 429186-71	`EC50=0.72 NOEC=0.016[8] LOEC 0.037[8]	0.0106	0.0212	0.0067	0.0134	0.0147	0.029	0.418	0.875
Freshwater Fish 429186-74	LC50=25 NOEC = 1.98[2] LOEC=4.52	0.0106	0.0212	0.0048	0.096	0.00042	0.0008	0.0024	0.0048
Estuarine Fish	LC50 = 39[3] NOEC = 0.07[4]	0.0106	0.0212	0.0048	0.096	0.00027	0.0005	0.0685	0.1371
Mysid toxicity	LC50=0.2[5] NOEC<0.0026 LOEC=0.0026	0.0106	0.0212	0.0067	0.0134	0.053***	0.106**	>4.076* ***	>8.153 ****
Sediment Organisms (chironomids)	LC50 = 0.72[7] NOEC = 0.016[8]	0.0106	0.0212	0.0067	0.0134	0.015	0.03	0.418	0.835

Most Sensitive Species Group Tested	Levels of Concern Acute (LC_{50}) Chronic (NOEC) (µg/L)	Peak EEC* (µg/L)		Chronic EEC[1] (µg/L)		Maximum Acute RQ's		Maximum Chronic RQ'S	
		Single Row	Double Row	Single Row	Double Row	Single Row	Double Row	Single Row	Double Row
Degradate MB46513									
Freshwater Invertebrate 429186-71	EC50=0.43[6] NOEC=0.022[8] LOEC =0.045[8]	0.001	0.002	0.0009	0.0018	0.0023	0.0046	0.0409	0.082
Freshwater Fish 429186-74	LC50=25 NOEC = 1.98[2] LOEC=4.52	0.001	0.002	0.0007	0.0014	0.00004	0.00008	0.00035	0.0007
Estuarine Fish	LC50 = 31[3] NOEC = 0.06[4]	0.001	0.002	0.0007	0.0014	0.000032	0.00006	0.0116	0.0232
Mysid toxicity	LC50=0.14 NOEC<0.005 LOEC=0.005	0.001	0.002	0.0009	0.0018	0.0071	0.0142	>0.18	>0.36
MB45950									
Freshwater Fish	EC50=83[3] NOEC=6.6[3] LOEC=15	0.0031	0.0062	0.0018	0.0036	0.000037	0.00007	0.00027	0.0005
Estuarine Fish	LC50 = 130[6] NOEC = 0.24[6]	0.0031	0.0062	0.0018	0.0036	0.000024	0.00005	0.0075	0.015
Freshwater Invertebrate	EC50=2.13 NOEC=0.277[8] LOEC=0.469[8]	0.0031	0.0062	0.0023	0.0046	0.00145	0.0029	0.0083	0.0166
Mysid toxicity	LC50 = 0.07[6] NOEC<0.005 LOEC=0.005	0.0031	0.0062	0.0023	0.0046	0.0442	0.0884* **	0.46	0.92
Sediment Organisms (chironomids)	LC50 = 2.13[7] NOEC = 0.28[8]	0.0031	0.0062	0.0023	0.0046	0.0015	0.003	0.0082	0.016

* Peak and chronic EECs for fipronil are based on PRZM/EXAMS. PEAK and chronic EECs for degradates are based on GENEEC. Although PRZM/EXAMS modeling was conducted for fipronil degradates, the one-in-ten year EECs were not used because accumulation was observed.

[1]Chronic Risk Quotients based on 1 year accumulated peak values.
[2] Most sensitive species tested acute value multiplied by chronic:acute ratio of parent fipronil
[3] Parent fipronil acute value multiplied by metabolite: parent fipronil ratio for freshwater fish acute values
[4] Parent fipronil chronic value multiplied by metabolite :parent fipronil ratio for freshwater fish acute values
[5] Acute freshwater metabolite value multiplied by acute estuarine:acute freshwater ratio for parent fipronil
[6] Assumed to be as toxic as the parent
[7] Based on mortality EC_{50}. Growth EC_{50} = 0.41 µg/L. EECs based on measured pore water concentrations
[8] Chironomid acute value divided by acute to chronic ratio for daphnid studies of compound
* Exceeds acute risk, restricted use, and endangered species LOCs
** Exceeds restricted use and endangered species LOCs
*** Exceeds endangered species LOCs
**** Exceeds chronic risk LOCs

Table 9. Acute and Chronic Risk Quotients for Freshwater and Estuarine Organisms for Fipronil and its Degradation Products in the Standard Pond From Only In-furrow Single and Double Row Corn Cropping Systems (ppb or µg L^{-1})

Most Sensitive Species Group Tested	Levels of Concern Acute (LC_{50}) Chronic (NOEC) (µg/L)	Peak EEC[1] (µg/L)		Chronic EEC[1] (µg/L)		Maximum Acute RQ's		Maximum Chronic RQ'S	
		Single Row	Double Row	Single Row	Double Row	Single Row	Double Row	Single Row	Double Row
Fipronil									
Freshwater Fish 429186-24	LC50=83 NOEC=6.6 LOEC=15 (parent)	0.2564	0.5128	0.0778	0.1556	0.003	0.006	0.011	0.023
Freshwater Invertebrate	EC50=0.43 NOEC=0.022[8] LOEC=0.045[8] (parent)	0.2564	0.5128	0.1529	0.3058	0.596*	1.19*	6.95****	13.9****
Estuarine Crustacea 432797-01	LC50=0.14 NOEC<0.005 LOEC=0.005 (parent)	0.2564	0.5128	0.1529	0.3058	1.83*	3.66*	>30.58* ***	>61.16* ***
Estuarine Mollusc 432917-01	EC50=770 (parent)	0.2564	0.5128	0.1529	0.3058	0.00033	0.00066	No Tox Data	No Tox Data
Estuarine Fish 432917-02	LC50=130	0.2564	0.5128	0.0778	0.1556	0.002	0.0039	No Tox Data	No Tox Data
Degradate MB46136									
Freshwater Invertebrate 429186-71	EC50=0.72 NOEC=0.016[8] LOEC =0.037[8]	0.0094	0.0184	0.006	0.012	0.0130	0.026	0.375	0.75
Freshwater Fish 429186-74	LC50=25 NOEC = 1.98[2] LOEC=4.52	0.0094	0.0184	0.0043	0.0086	0.0004	0.0008	0.0022	0.0043
Estuarine Fish	LC50 -= 39[3] NOEC = 0.07[4]	0.0094	0.0184	0.0043	0.0086	0.00024	0.00048	0.06	0.12
Mysid toxicity	LC50=0.14[5] NOEC<0.005 LOEC=0.005	0.0094	0.0184	0.006	0.012	0.067** *	0.13**	>1.2****	>2.4****
Sediment Organisms (chironomids)	LC50 = 0.72[7] NOEC = 0.016[8]	0.0094	0.0184	0.006	0.012	0.013	0.026	0.375	0.75
Degradate MB46513									
Freshwater Invertebrate 429186-71	EC50=0.43[6] NOEC=0.022[8] LOEC=0.045[8]	0.0009	0.0018	0.0008	0.0016	0.002	0.004	0.036	0.072
Freshwater Fish 429186-74	LC50=25 NOEC = 1.98[2] LOEC=4.52	0.0009	0.0018	0.0007	0.0014	0.00004	0.00007	0.00035	0.0007
Estuarine Fish	LC50 = 31[3] NOEC = 0.06[4]	0.0009	0.0018	0.0007	0.0014	0.00003	0.00006	0.012	0.023

Most Sensitive Species Group Tested	Levels of Concern Acute (LC_{50}) Chronic (NOEC) (µg/L)	Peak EEC[1] (µg/L)		Chronic EEC[1] (µg/L)		Maximum Acute RQ's		Maximum Chronic RQ'S	
		Single Row	Double Row	Single Row	Double Row	Single Row	Double Row	Single Row	Double Row
Mysid toxicity	LC50=0.14 NOEC<0.005 LOEC=0.005	0.0009	0.0018	0.0008	0.0016	0.0064	0.0129	>0.16	>0.32
MB45950									
Freshwater Fish	EC50=83[6] NOEC=6.6[6] LOEC=15	0.0028	0.0056	0.0016	0.0032	0.00003	0.00007	0.00024	0.00048
Estuarine Fish	LC50 = 130[6] NOEC = 0.24[6]	0.0028	0.0056	0.0016	0.0032	0.00002	0.00004	0.006	0.013
Freshwater Invertebrate	EC50=2.13 NOEC=0.277[8] LOEC=0.469[8]	0.0028	0.0056	0.0021	0.0042	0.0013	0.0026	0.0076	0.0152
Mysid toxicity	LC50=0.14[6] NOEC<0.005 LOEC=0.005	0.0028	0.0056	0.0021	0.0042	0.02	0.04	>0.42	>.084
Sediment Organisms (chironomids)	LC50 = 2.13[7] NOEC = 0.28[8]	0.0028	0.0056	0.0021	0.0042	0.0013	0.0026	0.0075	0.015

* Peak and chronic EECs for fipronil are based on PRZM/EXAMS. PEAK and chronic EECs for degradates are based on GENEEC. Although PRZM/EXAMS modeling was conducted for fipronil degradates, the one-in-ten year EECs were not used because accumulation was observed.

[1]Chronic Risk Quotients based on 1 year accumulated peak values.
[2] Most sensitive species tested acute value multiplied by chronic:acute ratio of parent fipronil
[3] Parent fipronil acute value multiplied by metabolite: parent fipronil ratio for freshwater fish acute values
[4] Parent fipronil chronic value multiplied by metabolite :parent fipronil ratio for freshwater fish acute values
[5] Acute freshwater metabolite value multiplied by acute estuarine:acute freshwater ratio for parent fipronil
[6] Assumed to be as toxic as the parent
[7] Growth EC_{50}/Mortality EC_{50}
[8] Chironomid acute value divided by acute to chronic ratio for daphnid studies of compound

* Exceeds acute risk, restricted use, and endangered species LOCs
** Exceeds restricted use and endangered species LOCs
*** Exceeds endangered species LOCs
**** Exceeds chronic risk LOCs

Most Sensitive Species Group Tested	Levels of Concern Acute (LC_{50}) Chronic (NOEC) (µg/L)	Peak EEC* (µg/L)		Chronic EEC[1] (µg/L)		Maximum Acute RQ's		Maximum Chronic RQ'S	
		Single Row	Double Row	Single Row	Double Row	Single Row	Double Row	Single Row	Double Row
Estuarine Fish	LC50 = 31[3] NOEC = 0.06[4]	0.0001	0.0002	0.00009	0.0001	0.00003	0.00006	0.0015	0.003
Mysid toxicity	LC50=0.14 NOEC<0.005 LOEC=0.005	0.0001	0.0002	0.0001	0.0002	0.0007	0.0014	>0.02	>0.04
MB45950									
Freshwater Fish	EC50=83[3] NOEC=6.6[3] LOEC=15	0.0003	0.0006	0.0002	0.0004	0.00000 4	0.00000 7	0.00006	0.00012
Estuarine Fish	LC50 = 130[6] NOEC = 0.24[6]	0.0003	0.0006	0.0002	0.0004	0.00000 2	0.00000 5	0.0008	0.0017
Freshwater Invertebrate	EC50=2.13 NOEC=0.277[8] LOEC=0.469[8]	0.0003	0.0006	0.0002	0.0004	0.00014	0.00028	0.00072	0.0014
Mysid toxicity	LC50 = 0.07[6] NOEC<0.005 LOEC=0.005	0.0003	0.0006	0.0002	0.0004	0.004	0.008	>0.04	>.0.08
Sediment Organisms (chironomids)	LC50 = 2.13[7] NOEC = 0.28[8]	0.0003	0.0006	0.0002	0.0004	0.00014	0.00028	0.0007	0.0014

* Peak and chronic EECs for fipronil are based on PRZM/EXAMS. PEAK and chronic EECs for degradates are based on GENEEC. Although PRZM/EXAMS modeling was conducted for fipronil degradates, the one-in-ten year EECs were not used because accumulation was observed.

[1]Chronic Risk Quotients based on 1 year accumulated peak values.
[2] Most sensitive species tested acute value multiplied by chronic:acute ratio of parent fipronil
[3] Parent fipronil acute value multiplied by metabolite: parent fipronil ratio for freshwater fish acute values
[4] Parent fipronil chronic value multiplied by metabolite :parent fipronil ratio for freshwater fish acute values
[5] Acute freshwater metabolite value multiplied by acute estuarine:acute freshwater ratio for parent fipronil
[6] Assumed to be as toxic as the parent
[7] Growth EC_{50}/Mortality EC_{50}
[8] Chironomid acute value divided by acute to chronic ratio for daphnid studies of compound

*	Exceeds acute risk, restricted use, and endangered species LOCs
**	Exceeds restricted use and endangered species LOCs
***	Exceeds endangered species LOCs
****	Exceeds chronic risk LOCs

Table 10. Acute and Chronic Risk Quotients for Freshwater and Estuarine Organisms for Fipronil and its Degradation Products in the Standard Pond From Only Seed Treatment with Single and Double Row Corn Cropping Systems (ppb or µg L^{-1})[1]

Most Sensitive Species Group Tested	Levels of Concern Acute (LC_{50}) Chronic (NOEC) (µg/L)	Peak EEC* (µg/L)		Chronic EEC[1] (µg/L)		Maximum Acute RQ's		Maximum Chronic RQ'S	
		Single Row	Double Row	Single Row	Double Row	Single Row	Double Row	Single Row	Double Row
Fipronil									
Freshwater Fish 429186-24	LC50=83 NOEC=6.6 LOEC=15 (parent)	0.0333	0.0666	0.0101	0.0202	0.0004	0.0008	0.0015	0.003
Freshwater Invertebrate (Stevens et. al. 1998)	EC50=0.43 NOEC=0.022[8] LOEC=0.045[8] (parent)	0.0333	0.0666	0.0198	0.0396	0.077***	0.154**	0.9	1.8****
Estuarine Crustacea 432797-01	LC50=0.14 NOEC<0.005 LOEC=0.005 (parent)	0.0333	0.0666	0.0198	0.0396	0.238**	0.476**	>3.96****	>7.92****
Estuarine Mollusc 432917-01	EC50=770 (parent)	0.0333	0.0666	0.0198	0.396	0.00004	0.00008	No Tox Data	No Tox Data
Estuarine Fish 432917-02	LC50=130	0.0333	0.0666	0.0101	0.0202	0.0026	0.0005	No Tox Data	No Tox Data
Degradate MB46136									
Freshwater Invertebrate 429186-71	EC50=0.72 NOEC=0.016[8] LOEC =0.037[8]	0.0012	0.0024	0.0007	0.0014	0.0016	0.0033	0.0438	0.0875
Freshwater Fish 429186-74	LC50=25 NOEC = 1.98[2] LOEC=4.52	0.0012	0.0024	0.0005	0.001	0.00005	0.0001	0.0025	0.0047
Estuarine Fish	LC50 = 39[3] NOEC = 0.07[4]	0.0012	0.0024	0.0005	0.001	0.00003	0.00006	0.007	0.014
Mysid toxicity	LC50=0.2[5] NOEC<0.0026 LOEC=0.0026	0.0012	0.0024	0.0007	0.0014	0.06***	0.12**	>0.269	>0.538
Sediment Organisms (chironomids)	LC50 = 0.72[7] NOEC = 0.016[8]	0.0012	0.0024	0.0007	0.0014	0.0016	0.00330	0.4375	0.875
Degradate MB46513									
Freshwater Invertebrate 429186-71	EC50=0.43[6] NOEC=0.022[8] LOEC =0.045[8]	0.0001	0.0002	0.0001	0.0002	0.00023	0.00047	0.0045	0.0090
Freshwater Fish 429186-74	LC50=25 NOEC = 1.98[2] LOEC=4.52	0.0001	0.0002	0.00009	0.0001	0.000004	0.000008	0.00005	0.00009

Aquatic Plant Risk

The EC_{50} for the aquatic plant species tested to date and the estimated aquatic concentrations from the proposed use on corn will not exceed acute toxicity levels for aquatic plants.

VII. TERRESTRIAL RISK ASSESSMENT

Likelihood of Exposure

Characterization of risk to non-target species is based on the expected environmental concentrations, the potential for exposure to non-target organisms from the proposed use and the known toxicity levels of this compound and it's degradates to the various species expected to be exposed in these agricultural settings. Based on the large acreage represented by corn production and the diversity of species found near these areas, a large number of terrestrial and aquatic species are likely to be potentially exposed. The registrant is also proposing to use the Regent 4SC product in narrow row spacing (15 inches between rows). The current minimum row spacing is 30 inches, and the proposed narrow row spacing will double the exposure on a per acre basis.

Avian and Mammalian Granular Exposure Risk Assessment

For granular pesticides the exposure is represented by the amount of active ingredient in a square foot area. This exposure value is then compared to the LD_{50} of the most sensitive test species to derive the risk quotient of an LD_{50} per square foot.

The LD_{50} per square foot for granular fipronil was based on T-Band and In-Furrow application rates (band width 7 inches for T-Band and 1 inch for in-furrow) of 8 ounces REGENT 1.5G per 1000 row feet. This is equivalent to 8.7 lbs of product per acre (0.13 lbs ai/acre) based on a 30-inch row spacing. As indicated in EPA's Risk Analysis for Granular Pesticides, the T-Band and In-Furrow application techniques are likely to leave 8% and 1%, respectively, of the applied granules on the surface and available to birds and mammals. These percentages are incorporated in the calculations. Maximum allowable amount applied per growing season is 8.7 pounds of the granular REGENT 1.5G product per acre (equivalent to 0.13 lbs ai/acre). The product is only applied at planting.

Calculation for Number of Avian LD_{50} per Square Foot for Incorporated T-Banded and In-furrow Applications

The following formula is used to calculate the LD_{50} per square foot for incorporated T-banded and in-furrow applications. It is the EFEDs policy to assume that 8% and 1% of the granules will be unincorporated and available to birds for T-banded and in-furrow applications respectively.

$$RQ = \frac{\text{oz. ai per 1000 ft.} * 28349 \text{ mg/oz} * \text{\% Unincorporated / bandwidth (ft)} * 1000 \text{ ft}}{\text{LD50(mg/kg)} * \text{Weight of the Animal (g)} * 1000 \text{ (g/kg)}}$$

T-Banded applications (7 inch band width)

$$\frac{0.8*0.015*28349*0.08*1000/0.583}{11.3*178*1000} = \frac{46681.029}{2011400} = 0.023 \text{ LD50/sq. ft.}$$

In-furrow applications (1 inch band width)

$$\frac{0.8*0.015*28349*0.01*1000/0.0833}{11.3*178*1000} = \frac{40838.896}{2011400} = 0.020 \text{ LD50/sq. ft.}$$

The proposed use of fipronil on corn does not exceed the LOCs for granular incorporated applications. These results are based on the bobwhite quail, the most sensitive species tested. The toxicity data indicate that degradate MB46513 is also very highly toxic to birds, with an LD_{50} value of 5 mg ai/kg-bw for the bobwhite quail. Substituting this value in the above equations gives LD_{50}/ft^2 values of 0.053 (T-Band) and 0.046 (In-Furrow), and the LOCs are still not exceeded. However, it should be noted that accumulation of MB46513 is possible because of its high persistence in terrestrial environments.

EFED currently has no methodology for assessing risks to small mammal populations from exposure to pesticides in granular formulation. Similarly, there currently is no methodology for assessing chronic reproductive risks to birds from exposure to granular pesticides.

Estimated Terrestrial Environmental Concentrations and Their Duration:

Exposures for terrestrial organisms are estimated using two approaches. The first approach, applicable to granular formulation applications involves calculation of granules and associated mass of active ingredient concentrations at the soil surface. The second approach, applicable to in-furrow spray applications, involves calculation of soil concentrations of fipronil and degradates and subsequent concentrations in selected dietary components of terrestrial receptors.

<u>Granular Formulation Terrestrial Exposure Estimates</u>

The labels for 1.5G and the 3G formulations of fipronil formerly proposed to permit T-band applications in 7 inch bands. It is important to note the registrant agreed to delete T-band use for the 1.5G and 3G formulations. There is also currently no request to convert the 3G formulation to an unconditional status. It is anticipated that adequate incorporation of granules will limit ingestion of most granules by birds foraging in soil. The Agency assumes that 1% and 8% granular exposure can occur from in furrow and T-band applications, respectively. This assumption would correspond to 0.41 mg a.i./ft^2 for in-furrow and 0.47 mg a.i./ft^2 for T-band applications.

<u>In-Furrow Spray Terrestrial Exposure Estimates</u>

Although the standard terrestrial exposure assessment assumes foliar deposition on different non-target crops, it may not be completely applicable because fipronil use on corn is strictly limited to in-furrow application. This type of application is expected to cause direct deposition on soil and limit direct foliar deposition. The maximum soil concentrations of fipronil from a single in furrow application could range from 33.94 ppm (ca.1 cm depth) to 2.26 ppm (ca. 15 cm depth). This concentration range accounts for application efficiency from the in furrow application process. These estimates are applicable only to soil particles and potential food sources in or surrounding furrows where ground sprays are applied. As nozzles will concentrate residues in small bands within the application site, residues on soil are expected to be limited to the immediate target zone of the spray.

Table 11 summarizes the estimated immediate posttreatment soil concentrations of fipronil and fipronil degradates (MB45950 and MB46136) as a result of in-furrow application.

Table 11. Estimated Soil Concentrations for Fipronil and Degradates In-Furrow Application (Immediately Posttreatment)

Chemical	Soil Concentration (mg/kg) ca 1 cm	Soil Concentration (mg/kg) ca 15 cm
fipronil	33.94	2.26
MB45950	1.69*	0.12
MB46136	8.14**	0.54

* assumes a 5% conversion efficiency
** assumes a 24% conversion efficiency

In-furrow spray application of fipronil to corn field soils is an application scenario not normally covered by routine exposure/risk assessment methods employed by EFED. Such a spray application does not involve application of active ingredient as a granule, precluding the use of the granular pesticide assessment methodology. Similarly, the extremely limited zone of spray application, restricted to individual furrows, would not involve general application across a field with concomitant residues on bare ground, foliage, etc. This would suggest that the use of Fletcher (1994) spray application residue values would not be reflective of such sprays applied to soil within individual furrows. Because the in furrow spray application is not compatible with these routine methods of risk assessment for terrestrial receptors, EFED utilized a new approach for evaluating the exposure to terrestrial birds and mammals potentially foraging in corn fields treated with fipronil by this in furrow spray method.

EFED has considered a variety of potential terrestrial receptors associated with corn fields. In selecting receptor organisms EFED has focused on species with a potential for feeding in corn fields and organisms with a comparatively wide geographical distribution that would afford a reasonable approximation of potential risks across the wide areas of potential fipronil use on corn. Terrestrial wildlife foraging in or near application furrows may be exposed to residues adsorbed to soil particles or accumulated in soil organisms. Under the in-furrow spray scenario, exposures to wildlife were calculated as an oral dose (average mg/kg-bw./day). The assessment of risk was based on comparison to oral toxicity thresholds for the most sensitive species tested. Three species were selected as terrestrial receptors: bobwhite quail, American robin, and meadow vole.

Pastorok et al. (1996) has summarized a basic chemical intake model for wildlife species to average daily dietary exposure dose for a given chemical of concern and a given receptor species. The general structure of this basic chemical intake model is as follows:

$$IR_{chemical} = \left[\sum (C_i)(M_i)(A_i)/W\right]$$

where: $IR_{chemical}$ is the species-specific total rate of intake of chemical by ingestion (mg/kg-bw/day)
C_i is the chemical concentration in medium $_i$ (mg/kg) (e.g., soil, water, and dietary components)
M_i is the rate of ingestion of medium $_i$ (kg/day)
Ai is the gastrointestinal absorption efficiency of the chemical in medium$_i$ relative to absorption in laboratory toxicity tests
W is the body weight of the receptor species (kg)

This basic model was used to estimate oral dose exposures for the three receptor species selected for risk assessment. Because of a lack of data regarding absorption efficiencies both in the available toxicity studies and for free-living receptors, the absorption efficiency (A_i) for all three receptor species was conservatively assumed to be 100% or 1.0.

The model used for estimating oral dose exposure for the robin was based on a simple two-component model that considered incidental ingestion of soil and consumption of soil invertebrates (i.e., earthworms). The equation describing this model is as follows

$$\text{robin exposure in mg/kg-bw/day} = \frac{((C_{worm}\text{ mg/kg})(0.15)(0.0082\text{ kg food/day}) + (C_{ss}\text{ mg/kg})(0.00082\text{ g soil/day})}{0.081\text{ kg body weight}}$$

where: C_{worm} is the estimated concentration in earthworms as calculated by fugacity relationships and the predicted concentration of chemical over a 15 cm soil profile (see explanation below)
0.15 is the fraction of robin diet attributable to earthworms (EPA 1993)
0.0082 kg food/day is the food ingestion rate for adult robins as calculated using allometric relationships from Nagy (1984)
C_{ss} is the predicted concentration of chemical in the upper 1 cm of soil. The chemical over the 1cm soil depth was selected as the reasonable depth-integrated concentration available for incidental soil ingestion
0.00082 kg soil/day is calculated from the fraction of diet (0.1) that consists of incidentally ingested soil as per data for soil invertebrate feeding birds (Beyer et al. 1994, EPA 1993) and the estimated daily dietary intake as per Nagy (1987)
0.081 kg body weight is the average body weight of adult robins for data reported in EPA (1993)

The model for estimating oral exposure for the bobwhite considered incidental soil exposure only. Data available in EPA (1993) suggest that bobwhite quail are not routine consumers of earthworms, hence the limitation of the exposure model to incidental soil ingestion only. The model is as follows

$$\text{quail exposure in mg/kg-bw/day} = \frac{(C_{ss}\ \text{mg/Kg})(0.00139\ \text{kg soil/day})}{0.178\ \text{kg body weight}}$$

where: C_{ss} is the predicted concentration of chemical in the upper 1 cm of soil. The fipronil over the 1cm soil depth was selected as the reasonable depth-integrated concentration available for incidental soil ingestion

0.00139 kg soil/day is an assumed fraction of diet that consists of incidentally ingested soil as per data for gallinaceous birds 0.094 of daily diet mass (Beyer et al. 1994, EPA 1993) and a calculated dietary intake of 14.74 g as per Nagy (1987)

0.178 kg body weight is the average body weight of adult quail for data reported in Dunning (1984)

The meadow vole exposure model considers incidental ingestion of soil only. Available data in EPA (1993) suggest that meadow voles do not routinely consume earthworms. The exposure model is as follows:

$$\text{meadow vole exposure in mg/kg-bw/day} = \frac{(C_{ss}\ \text{mg/Kg})(.00035\ \text{kg soil/day})}{0.043\ \text{kg body weight}}$$

where: C_{ss} is the predicted concentration of chemical in the upper 1 cm of soil. The fipronil over the 1cm soil depth was selected as the reasonable depth-integrated concentration available for incidental soil ingestion

0.00031 kg soil/day is an assumed fraction of diet that consists of incidentally ingested soil as per data for meadow voles 0.024 of daily diet mass (Beyer et al. 1994, EPA 1993) and a calculated dietary intake of 13.05 g as per EPA (1993)

0.043 kg body weight is the average body weight of adult meadow voles EPA (1993)

An estimation of fipronil and its degradate concentrations potentially accumulated in the tissues of earthworms was required to complete the exposure estimates for robins. This estimation of earthworm concentration was calculated using a fugacity-based (equilibrium partitioning) approach based on the work of Trapp and McFarlane (1995) and Mackay and Paterson (1981). Earthworms dwelling within the soil are exposed to contaminants in both soil pore water and via the ingestion of soil (Belfroid et al. 1994). The concentrations of fipronil and its degradates in earthworms were calculated as a combination of uptake from soil pore water and gastrointestinal absorption from ingested soil:

$$C_{earthworm} = [(C_{soil})(Z_{earthworm}/Z_{soil})]+[(C_{soil\ water})(Z_{earthworm}/Z_{water})]$$

where: C_{soil} is the concentration of chemical in bulk soil (note: a chemical concentration averaged over a 15 cm soil depth was used to reflect a concentration across the earthworm occupied area of soil)

$Z_{earthworm}$ is the fugacity capacity of chemical in earthworms = $(lipid)(K_{ow})(\rho_{earthworm})/H$

Z_{soil} is the fugacity capacity of chemical in soil = $(K_d)(\rho_{soil})/H$

Z_{water} is the fugacity capacity of chemical in water = $1/H$

$C_{soil\ water}$ is the concentration of chemical in soil water = C_{soil}/K_{bw}

K_{bw} is the bulk soil-to-water partitioning coefficient = $(\rho_{soil})(K_d)+\theta+(\epsilon-\theta)(K_{aw})$

K_{aw} is the air-to-water partitioning coefficient = H/RT

H = Henry's Constant specific to fipronil or degradate

R = universal gas constant, 8.31 Joules-m^3/mol-°K

T = temperature °K, assumed to be 298 °K

K_d = soil partitioning coefficient = (chemical K_{oc})(0.02 assumed fraction of soil organic carbon)

ρ_{soil} = bulk density of soil, assumed to be 1.3 g/cm^3

θ = volumetric fraction of the soil, assumed to be 0.30

ϵ = volumetric total porosity of the soil, assumed to be 0.50

lipid = fraction of lipid in organism 0.01 (Cobb et al. 1995)

K_{ow} = fipronil or degradate octanol to water partitioning coefficient

$\rho_{earthworm}$ = the density of the organism g/cm^3, assumed to be 1 g/cm^3

Table 12 summarizes the model inputs and exposure estimates for robins, bobwhite quail, and meadow voles.

Table 12. Model Input Parameters and Dietary Exposure Estimates for Avian and Mammalian Receptors (for Soil Concentrations Immediately Posttreatment)

Parameter	Fipronil	MB45950	MB46136
C_{soil} (mg/kg @ 15 cm depth)*	2.26	0.124	0.54
C_{ss} (mg/kg @ 1 cm depth)	33.94	1.69	8.14
Henry's Constant (Pa-m^3/mole)	4.406E-01	6.37E-03	1.315E-01
R universal gas constant (Joules-m^3/mol-°K)	8.314	8.314	8.314
T °K	298	298	298
K_{ow}	10570	6310	2818
K_d (L/kg)	14.54	84.12	54.36
Z_{water} (1/H or moles/Pa-m^3)	2.269632	156.9859	7.604563
Z_{soil} (($K_d \bullet \rho_{soil}$)/H)	42.90059	17167.35	537.3992
$Z_{earthworm}$ ((lipid$\bullet K_{ow} \bullet \rho_{earthworm}$)/H)	239.9001	9905.181	214.327
$C_{soil\ water}$ (mg/L)	0.117696	0.001131	0.007609
ρ_{soil} (g/cm^3)	1.3	1.3	1.3
$\rho_{earthworm}$ (g/cm^3)	1	1	1
θ (unitless)	0.3	0.3	0.3
ϵ (unitless)	0.5	0.5	0.5
K_{aw} (H/RT)	0.000178	0.0000026	0.000053
K_{bw} (($\rho_{soil} \bullet$Kd)+θ+(ϵ-θ)(K_{aw}))	19.20204	109.656	70.96801
Earthworm Concentration (mg/kg)	25.08	0.14	0.43
Robin Oral Dose (mg/kg-bw/day)	0.72	0.02	0.09
Quail Oral Dose (mg/kg-bw/day)	0.26	0.01	0.06
Meadow Vole Oral Dose (mg/kg-bw/day)	0.25	0.01	0.06

*Concentrations are based on in-furrow spray application to surface at 44 mg/ft^2

For chronic fipronil and degradates oral dose exposures to the robin, bobwhite quail, and meadow vole, a 20-week average concentration of each compound immediately following application was calculated in soil over 1 cm and 15 cm depth profiles. Twenty weeks was selected as the averaging period to be consistent with the exposure durations encountered in available rat multi-generation and avian reproduction toxicity studies. Table 13 summarizes these estimated soil concentrations.

Table 13. Estimated Soil Concentrations for Fipronil and Degradates In-Furrow Application (20-Week Average Soil Concentrations*)

Chemical	Soil Concentration (mg/kg) ca 1 cm	Soil Concentration (mg/kg) ca 15 cm
fipronil	22.04	1.55
MB45950	1.55**	0.11
MB46136	7.45***	0.49

* 20-week average assumes $t_{1/2}$ of 128 days
** assumes a 5% conversion efficiency
*** assumes a 24% conversion efficiency

Using the 20-week average soil concentrations in the avian and mammalian receptors yields the following estimated maximal year one chronic oral dose estimates (Table 14).

Table 14. Chronic Oral Dose Estimates for Avian and Mammalian Receptors (Maximum Year 1 20-Week Average)

Receptor	Fipronil Chronic Dose (mg/kg-bw/day)	MB45950 Chronic Dose (mg/kg-bw/day)	MB46136 Chronic Dose (mg/kg-bw/day)
Robin	0.48	0.018	0.082
Bobwhite quail	0.17	0.012	0.058
Meadow vole	0.16	0.011	0.055

Multiple Year Considerations

It should be emphasized that the dietary exposure estimates for avian and mammalian receptors are for the first year of treatment only. The environmental stability of fipronil degradates suggests that there will be carry-over of annual application residues from year to year. With additional consecutive applications of fipronil to corn fields, it is likely that fipronil degradate concentrations in years following the initial application will increase. Figure 2 presents the impact of multiple-year applications of fipronil on the concentration of degradates in soil over the 1 cm and 15 cm depth profiles used in the exposure assessment. This data (generated on the assumption that degradate half-lives are on the order of 700 days) indicate that 1 cm depth fipronil concentrations are likely to accumulate to levels substantially greater that those estimated for the first year of application. More refined and less uncertain estimates of this multiple year accumulation phenomena would require additional information with respect to the aerobic soil metabolism of fipronil degradates.

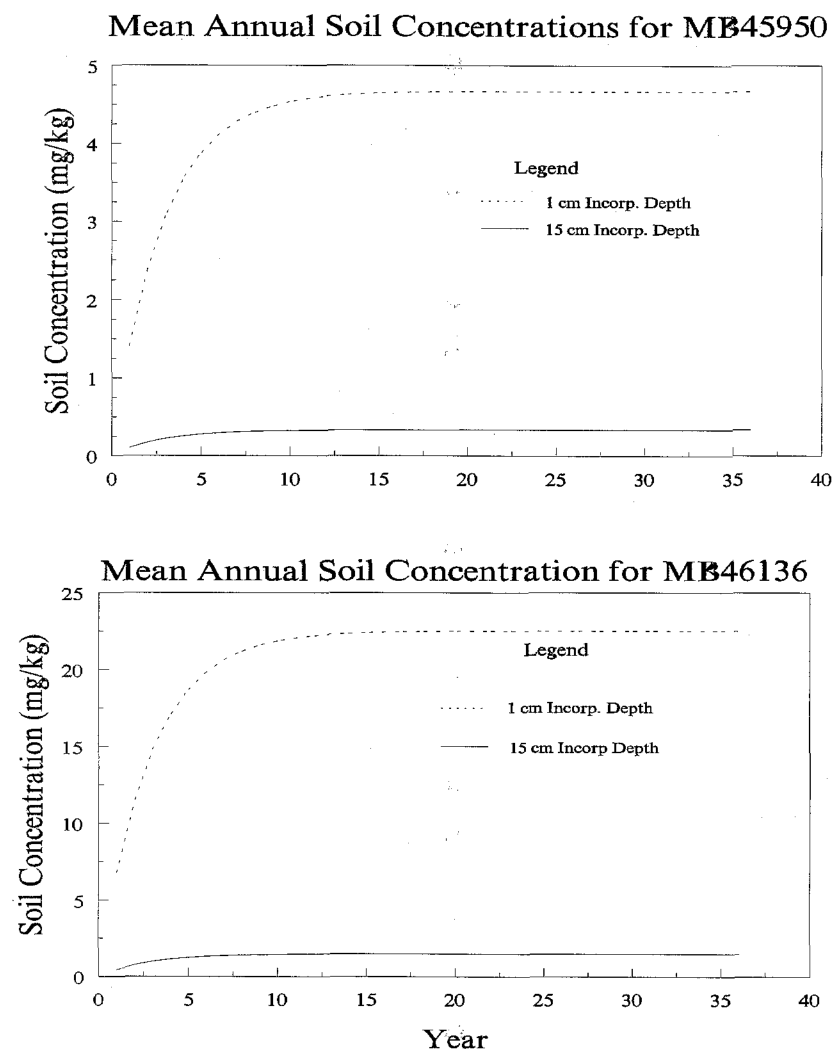


Figure 2. Accumulation Profiles for Fipronil Degradates in Soils after Repeated Annual Application to Corn Fields

Avian and Mammalian Risk Assessment from Exposure to In-Furrow Spray Residues

__Acute Risks__

Maximal oral dose estimates of exposure for robins, bobwhite quail, and meadow voles were compared with available acute toxicity (LD_{50}) data. The LD_{50} for bobwhite quail was used as a estimate of the potential toxicity of fipronil to robins and bobwhite quail. In the absence of acute toxicity data specific to the robin, this is a conservative approach for assessing the toxicity of fipronil to this species. Fipronil and degradate toxicity to the meadow vole was estimated using toxicity data for laboratory rats. Because acute avian toxicity data were not available for the degradates of concern (MB45950 and MB46136), the toxicity data for fipronil were used to represent the potential toxicity of degradates to avian species. Available data for the photodegradate MB46513 suggests that degradates possessing the F_3C- moiety of the parent compound may be as least as toxic as parent fipronil. Similarly, the absence of acute toxicity data for MB45950 necessitated an assumption that this degradate was similar in toxicity to parent fipronil. Table 15 summarizes the estimation of acute Risk Quotients for avian and mammalian species potentially exposed to fipronil and degradates as a result of in-furrow spray applications.

Table 15. Acute Dietary Risk Quotients for Avian and Mammalian Terrestrial Receptors

Species	Acute Toxicity* (mg/kg-bw)	Oral Dose Estimate (mg/kg-bw/day)	Acute Dietary Risk Quotient (In-Furrow Spray)
American Robin	fipronil LD50 11.3	0.72	0.06
	MB45950 LD50 11.3**	0.02	0.002
	MB46136 LD50 11.3**	0.09	0.008
Bobwhite Quail	fipronil LD50 11.3	0.26	0.02
	MB45950 LD50 11.3 **	0.01	0.001
	MB46136 LD50 11.3 **	0.06	0.005
Meadow Vole	fipronil LD50 97	0.25	0.003
	MB45950 LD50 97 **	0.01	0.0001
	MB46136 LD50 218	0.06	0.0003

* Toxicity for robin is conservatively based on bobwhite quail, the most sensitive species tested. Toxicity for meadow vole is based on toxicity data for laboratory rats.

**In the absence of toxicity data to the contrary, the toxicities of degradates were assumed to be equivalent to parent fipronil. This assumption was based on the presence of the biologically active F_3C- moiety on degradates, the structural moiety indicated by the registrant as the biologically active structure responsible for fipronil toxicity.

The Risk Quotients comparing acute LOCs to estimated dietary exposures to fipronil and its degradates in soil and soil invertebrates for two representative bird species (robin and bobwhite quail) are orders of magnitude below 1. In-furrow spray applications of fipronil do not appear to pose an acute risk to avian species. Similarly fipronil's proposed use on corn does not appear to present an acute risk to small mammals similar in size and sensitivity to the rat. Incidental exposures to fipronil and its degradates in soil are orders of magnitude below acute mammalian LOCs at proposed rates for corn use.

Chronic Risks

Estimated soil concentrations of fipronil and degradates averaged over the first 20 week period following an in-furrow spray application were used to estimate chronic oral dose exposures for robins, bobwhite quail, and meadow voles through consumption of soil and soil invertebrates. These 20 week average concentrations were then compared to available chronic LOCs for birds and mammals. As discussed in the toxicological review section of this assessment, the NOEL (26.03 mg/kg-bw/day) for reduced litter size, reduced weanling survivability, and reduced mating from a rat multi-generational reproductive study serves as the LOC for the chronic mammalian assessment of risk. For avian species, the reproductive data is for bobwhite quail showed no effects at a dietary concentration of 10 mg/kg. This dietary concentration is equivalent to an oral dose exposure of 0.88 mg/kg-bw/day, which is used as the chronic LOC for avian species. Table 16 summarizes the chronic Risk Quotients derived by this comparison.

Table 16. Chronic Dietary Risk Quotients for Avian and Mammalian Terrestrial Receptors

Species	ChronicToxicity* (mg/kg-bw)	Oral Dose Estimate (mg/kg-bw/day)	Chronic Dietary Risk Quotient (In-Furrow Spray)
American Robin	fipronil NOEL 0.88	0.48	0.55
	MB45950 NOEL 0.88 **	0.018	0.02
	MB46136 NOEL 0.88 **	0.082	0.09
Bobwhite Quail	fipronil NOEL 0.88	0.17	0.19
	MB45950 NOEL 0.88 **	0.012	0.01
	MB46136 NOEL 0.88 **	0.058	0.07
Meadow Vole	fipronil NOEL 26.03	0.16	0.006
	MB45950 NOEL 26.03 **	0.011	0.0004
	MB46136 NOEL 26.03**	0.055	0.002

* Toxicity for robin is conservatively based on bobwhite quail, the most sensitive species tested. Toxicity for meadow vole is based on toxicity data for laboratory rats.
**In the absence of toxicity data to the contrary, the toxicities of degradates were assumed to be equivalent to parent fipronil. This assumption was based on the presence of the biologically active F_3C- moiety on degradates, the structural moiety indicated by the registrant as the biologically active structure responsible for fipronil toxicity.

Risk Quotients comparing 20-week estimated maximum oral doses (year 1 of application) with reproduction-based chronic LOCs for robins, bobwhite quail, and meadow voles are all less than 1. Based on these risk quotients, first year application of fipronil by in-furrow spray do no pose a chronic risk to avian and mammalian species expected to use corn fields as a dietary source area.

Nontarget Beneficial Insect Risk

The Agency cannot characterize the risk of adverse impacts to beneficial insects from application of fipronil insecticide products. The honeybee acute contact LD_{50} and the honeybee residue study on foliage are not needed to support in-furrow applications to corn. However, the studies will be needed to support foliar ground spray and aerial application of fipronil. To date, the agency has only received a honeybee residue study on foliage. It is assumed that hazardous impacts to honeybees and other beneficial insects are unlikely if fipronil is properly incorporated. It is also assumed that fipronil has been tested by the registrant and found to be highly toxic to honeybees as there is a label statement to this effect on the REGENT 80 WG label. Impacts to beneficial soil invertebrates, such as earthworms, are probable given the mode of action for fipronil and it's incorporation into soils.

Endangered Species Concerns

Fipronil use on corn does offer potential acute hazard to sensitive endangered avian species feeding in corn fields. Within the corn field insectivorous birds and small mammals, such as field mice or voles, feeding on emerging insects near treated furrows may be subject to ingestion of potentially harmful residues. Avian sensitivity is expected to be extremely species dependent as it was with bobwhite and mallard. The deeper the incorporation of granules or sprayed soils, the less likelihood of avian or mammalian exposure. This is particularly important on bare, recently plowed soils which often attract avian species due to ease of locating exposed soil invertebrates.

The use of fipronil on corn is expected to offer potential hazard to endangered aquatic invertebrates located in surface or subterranean waters. Little breakdown is expected if fipronil reaches underground water systems due to the absence of the primary source of degradation: exposure to sunlight. Shallow stream organism may be less effected if waters are clear, rapidly moving, and exposed to sunlight. Concentration in shaded pools could cause a exposure to potentially hazardous residues for sensitive listed species of invertebrates.

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APPENDIX A -- Aquatic Exposure Assessment -- Additional Information

Summary

The environmental fate data for fipronil are generally acceptable to formulate a comprehensive fate and transport assessment. The environmental fate assessment for fipronil metabolites is more uncertain because of the lack persistence data in terrestrial and aquatic environments. Data gaps force an assumption of high persistence for environmental fate and transport modeling.

Based on PRZM-EXAMS modeling of the index reservoir, peak and 36 year annual average concentrations from single row in-furrow applications of fipronil are not expected to exceed 630 ng L^{-1} and 23 ng L^{-1}, respectively. The double row in-furrow use is expected to be double the predicted concentrations from single row in-furrow applications. The peak and 36 year annual average concentration for double row spacing are not expected to exceed 1260 ng L^{-1} and 46 ng L^{-1}, respectively. The impact of seed treatment alone on fipronil residue concentrations are expected to be 13% of the reported in-furrow concentrations. In contrast, the combination of in-furrow and seed treatments is expected to produce fipronil concentrations at 113% of the in-furrow concentrations. The peak and 36 year annual average concentration for combined seed and double row in-furrow use are not expected to exceed 1423.8 ng L^{-1} and 51.8 ng L^{-1}, respectively. Lower concentrations of degradation products are expected because of water flow through the index reservoir. The lack of water flow through the reservoir is expected to allow residue accumulation in drinking water. The peak and 36 year annual average concentrations for double row in-furrow and seed treatment combination are not expected to exceed 14 and 3 ng L^{-1} for MB46513, 221.2 and 63.4 ng L^{-1} for MB46136, and 51.8 and 15.2 ng L^{-1} for MB45950.

Based on PRZM-EXAMS modeling of the standard pond, peak and 21 day average concentrations from single row in-furrow applications of fipronil are not expected to exceed 256.4 ng L^{-1} and 152.9 ng L^{-1}, respectively. The double row in-furrow use is expected to be double the predicted concentrations from single row in-furrow applications. The peak and 21 day average concentrations for double row spacing are not expected to exceed 512.8 ng L^{-1} and 305.8 ng L^{-1}, respectively. The impact of seed treatment alone on fipronil residue concentrations are expected to be 13% of the reported in-furrow concentrations. In contrast, the combination of in-furrow and seed treatments is expected to yield concentrations at 113% of the in-furrow concentrations. The peak and 21 day average concentration for combined seed and double row in-furrow use are not expected to exceed 579.4 ng L^{-1} and 345.4 ng L^{-1}, respectively.

The first year of runoff simulation (1948) was used as the reference concentrations in the standard pond. The peak and 36 year annual average concentrations for double row in-furrow and seed treatment combination are not expected to exceed 2 and 1.8 ng L^{-1} for MB46513, 21.2 and 13.4 ng L^{-1} for MB46136, and 6.2 and 4.6 ng L^{-1} for MB45950. Higher concentrations are expected from successive years of use because of the high persistence of fipronil degradation products.

Based on the SCI-GROW model, acute and chronic drinking water concentrations in shallow ground water from double row in-furrow uses with treated seed are not likely to exceed 0.0236 µg/L for parent fipronil, 0.0009 µg/L for MB 46136, 0.0002 µg/L for MB 46513, and 0.0003

µg/L for MB 45950. These concentrations are expected to be the highest fipronil residue concentrations for fipronil corn uses.

Modeling Parameters

The dissipation of fipronil in surface water should be dependent on photodegradation in water and, to a lesser extent, microbial-mediated. Since photolysis is a major route of degradation for fipronil, its dissipation is expected to be dependent on physical components of the water (*i.e.* sediment loading) which affect sunlight penetration. For example, fipronil is expected to degrade faster in clear, shallow water bodies than in murky and/or deeper waters. Since fipronil and its transformation products have moderate soil-water partitioning coefficients, binding to sediments may also be a route of dissipation.

The following data were used as input for the PRZM/EXAMS modeling of fipronil:

Parameter	Value	Source
Application rate	0.1456 kg/ha	REGENT 4SC
Soil K_{oc}	727 mL/g[1]	MRID 44039003
Aerobic soil half-life	128 days	MRID 42918663
Plotolysis Half-life	0.16 days	MRID 42918661
Hydrolysis pH 7	Stable	MRID 42194701
Aerobic Aquatic Half-life	33.7 days[2]	MRID 44661301, 44261909
Anaerobic Aquatic Half-life	33.7 days[2]	MRID 44661301, 44261909
Water solubility	2.4 mg/L	EFGWB one-liner

1- Mean Koc value
2-Represents the 90th percentile of the mean

EFED notes differences in K_{oc} input parameters for current modeling and earlier PRZM-EXAMS surface water modeling. Earlier Tier II assessment was conducted using a mean K_{oc} of 803 mL/g (Mostaghimi, 1996). Subsequent review of the available data suggest that this earlier K_{oc} was an over-estimate. The correct mean K_{oc} of fipronil is 727 mL/g. Although the surface water models are sensitive to K_{oc}, the slight difference in fipronil K_{oc} is expected to only slightly increase the estimated environmental concentrations. The mean K_{oc} was used because there was an observed correlation between K_d and soil organic matter.

The lowest reported half-life of fipronil ($t_{1/2}$= 128 days) was used as the representative aerobic soil metabolism half-life of fipronil. Preliminary analysis indicates the upper 90th percentile half-life value of the mean is much greater than the highest reported value ($t_{1/2}$= 308 days). The highest reported half-life is associated with a low organic matter sand, which likely represents a soil type of limited microbial activity. It should be noted that the use of the lowest half-life is a departure from current EFED policy, which states that the 90[th] percentile of the mean should be used for modeling purposes. However, the use of the lower half-life is not expected to alter PRZM/EXAMS predictions because the model is relatively insensitive with respect to this parameter for moderately to persistent compounds.

EFED notes that rapid degradation of fipronil ($t_{1/2}$=14 days) in the aerobic aquatic metabolism study is inconsistent with both aerobic soil metabolism and anaerobic aquatic metabolism data on fipronil. Additionally, interpretation of the study results are further confounded by a highly stratified redox potential between the water and sediment phases. These data appear to contradict the persistence of fipronil ($t_{1/2}$=128 to 308 days) in aerobic soil metabolism studies. The registrant has submitted additional aerobic aquatic data showing first-order half-live for fipronil was 16 days for Ongar and 35.62 days for Manningtree sediment/water systems (RPA Document 201604). Based on the available aerobic aquatic metabolism data, the 90[th] percentile aerobic aquatic half-life for fipronil is 33.7 days. This half-life was used in the EXAMS modeling for KBACW and KBACS.

EFED conducted surface water modeling for the individual degradates including MB 46513, MB 46136 and MB45950. Environmental fate properties of the fipronil degradates are shown in Table 1. The modeling was conducted assuming the maximum daily conversion efficiency for the compound was represented by the maximum percentage formed in the environmental fate laboratory studies. The maximum daily conversion efficiency was 24% for MB 46136 (MRID 42928663), 1% for MB 46513 (MRID 42918661), and 5 % for MB 45950 (MRID 42928663). It should be noted that anaerobic aquatic metabolism data (MRID 43291704) indicate the conversion efficiency for MB 45950 can be substantially higher than 5% under anoxic conditions. The highest conversion efficiencies for MB 45950 was not used in the modeling because it represents anoxic sediment environments. Similarly, the conversion efficiency for MB 46513 in aqueous photolysis studies (MRID 42918661) was not used because in-furrow uses of fipronil are expected to limit photodegradation processes. Degradate application was assumed to coincide with fipronil application. Because the fipronil degradates are formed through abiotic or biotic degradation pathways in soil and water, the degradates were assumed to have a 100% application efficiency on the soil surface. This approach for estimating degradate concentrations is expected to be conservative.

Table 1: Fate Properties of Fipronil Degradates

Fate Parameter	MB 46136	MB 46513	MB 45950
Mean Koc	4208 mL/g	1290 mL/g	2719 mL/g
Aerobic Soil Metabolism Half-life	700 days	660 days	700 days
Aqueous Photolysis Half-life	7 days	Stable	Stable
Hydrolysis Half-life	Stable	Stable	Stable
Aquatic Metabolism Half-lives	1400 days	1320 days	1400 days
Water Solubility	0.16 mg/L	0.95 mg/L	0.1 mg/L
Single Row Spacing Application Rate (kg a.i./ha)	0.0349	0.0014	0.0072
References	**RP# 201555 ACD/EAS/Im/255 Theissen 10/97**	MRID 44262831 44262830 **Theissen 10/97**	**RP 201578 Theissen 10/97**

PRZM (3.12 version) and EXAM (2.97.5) were used for Tier II simulations for in-furrow single row spaced corn. Fipronil and degradate water concentrations for the double row spacing and corn seed treatment were estimated through proportional adjustment of water concentration for application rate. Water concentrations for double row spacing were estimated at 100% (2X higher) of the single row spaced in-furrow use. Seed treatment alone and dual in-furrow/seed treatment use were estimated at 13%, and 113%, respectively, of the water concentrations for single and double row spaced corn. This approach was taken because fipronil use on corn is associated with in-furrow application techniques such as a seed treatment or in-furrow spray. The combination of in-furrow and seed treatment use of fipronil was modeled because the label does not restrict dual fipronil applications.

The Tier II assessment was conducted on a corn site in the Southern Mississippi Uplands (MLRA-134). The soil on the site is classified as a Grenada silt loam (fine-silty, mixed, Thermic Glossic Fragiudalfs). Please see attached PRZM-EXAM assessment. The Tier II assessments were conducted on a soil with a very dense "hard pan" horizon commonly known as a fragipan. A fragipan can encourage lateral flow of water because of water impedance through the soil profile. The soil hydrology effects associated with the presence of a fragipan were not considered in the modeling. The metrology file used in the simulations were from MET 134. The weather data limited assessment to twenty years from 1948 to 1983. Simulations were conducted using EXAMS environment files for the farm pond (MSPOND.ENV) and a Mississippi index reservoir

(IRMSCOTN. ENV). The mean stream flow in the index reservoir watershed was 53.22 m^3/hour. Details regarding the index reservoir and the percent crop area (PCA) factor can be found at the following websites ((www.epa.gov/pesticides/scipoly).

Fipronil residue concentrations, expressed as fipronil equivalence, are presented as individual concentrations and as cumulative fipronil residues. The cumulative residue approach assumes that fipronil and its degradation products have equal toxicity profiles.

Surface Water Monitoring

Based on preliminary data from the Louisiana Department of Agriculture and Forestry from 23 monitoring sites in Calcasieu, Jefferson-Davis, Allen, Evangeline, Acadia, and Vermilion Parishes, the maximum concentration of fipronil residues was 8.41 ug/l for fipronil, 1.96 ug/L for MB46513, 0.50 ug/L for MB46136, and 0.32 ug/L for MB45950 from March 6, 2000 to May 15, 2000. The detections frequencies (number of detection/total number of samples) were 85% for fipronil, 32% for MB46513, 11.7% for MB46136, and 6.9% for MB45950. Because the monitoring data were derived from presentation materials, the level of detail is insufficient to assess data quality.

The registrant (Aventis) has submitted surface water monitoring data for the Mermentau River and Lake Arthur (MRID 453499-01). The Mermentau River drains a large portion of the rice acreage in southern Louisiana from the mouths of Bayou Plaquemine and Bayou Nezpique. It should be noted this area does not have any community water systems using surface source water. The monitoring program was designed to provide a snapshot of concentrations on May 11, 1999 from 0-to-1 feet and 4 to 6 feet depth. Low rainfall was observed (0.5 inches) from March 14 to May 9, 1999. Point samples were taken using a 1 L beaker for surface samples at depth of 1 feet and PVC tube sample at 5.5 feet depth Samples were taken from 14 sampling points from the north to south including the mouth of the Bayou Plaquemine, mouth of the Bayou Nezpique, 10,8,6,4,2,1 miles north of Lake Arthur Bridge; Lake Arthur Bridge, and 1,2,3,4, and 5 miles south of Lake Arthur Bridge. The reviewer notes that sample preparation (e.g. filtering) is not described in the submission. Concentrations of Fipronil, MB46513, MB45950, and MB46136 in water were determined by LC/MS/MS method. The limit of detection (LOD) and limit of quantification (LOQ) were 0.004 ug/L and 0.010 ug/L, respectively. Recoveries from spiked water samples at 0.10 ug/L ranged from 86.4 to 105.4%.

The maximum concentration of fipronil residues at the mouth of the Bayou Plaquemine were 2.118 ug/L for fipronil in the 4 to 6 feet sample, 1.004 ug/L for MB46513 in the 0 to 1 feet sample, 0.269 ug/L for MB45950 in the 0 to 1 feet sample, and 0.270 ug/L for MB46136 in the 0 to 1 feet sample. The maximum total fipronil residue (summation of fipronil,MB46513, MB45950, and MB46136) concentration was 3.509 ug/L. There was a slight decrease in concentration downstream from the mouth of Plaquemine river to 5 miles south of Lake Arthur (18 miles downstream); concentrations were 1.027 ug/L for fipronil, 0.343 ug/L for MB46513, 0.034 ug/L for MB45950, and 0.130 ug/L for MB46136.

Appendix B: Environmental Fate Data

DEGRADATION

Hydrolysis (161-1)
MRID No. 42194701

Radiolabelled fipronil was stable (<3% degraded by day 30 posttreatment) in pH 5 and pH 7 buffered solutions and hydrolyzed slowly ($t_{1/2}$=28 days) in pH 9 buffer solutions. The major degradate of fipronil was RPA 200766. In pH 9 buffer solution, RPA 200766 reached a maximum concentration of 51.7% of applied radioactivity at 30 days posttreatment. These data suggest that abiotic hydrolysis of fipronil is an alkaline-catalyzed degradation process.

The study (MRID 42194701) fulfills the hydrolysis (161-1) data requirement for fipronil. No additional data are needed at this time.

Photodegradation in water (161-2)
MRID No. 42918661
Ref.#ID: ACD/EAS/Im/255 (Interim Study)

Radiolabelled fipronil had a half-life of 3.63 hours in pH 5 buffer solution when irradiated with Xenon light. There was no fipronil degradation in the dark controls. Two degradates, MB46513 and RPA 104615, were identified in irradiated test samples. MB 46513 reached a maximum concentration of ≈43% of applied radioactivity at 6 hours postexposure. RPA 104615 reached a maximum concentration of ≈8% of applied radioactivity. One unidentified degradate, characterized as with a molecular weight of 410 a.m.u., reached a maximum concentration of ≈5.5% of applied radioactivity. Radioactive volatiles were not detected (<0.04% of applied radioactivity) in ethylene glycol and NaOH gas traps.

The study (MRID 42918661) fulfills the photodegradation in water data requirement (161-2). No additional data are needed at this time.

Photodegradation on soil (161-3)
MRID No. 42918662

Radiolabelled fipronil had a half-life of 34 days (dark control corrected half-life = 110 days) on loam soil when exposed to intermittent (8 hour photodegradation period) Xenon light. Radiolabelled fipronil had a half-life of 49 days in dark controls. Photodegradates were RPA 200766 (11% of applied), MB 46136 (4% of applied), MB 45590 (1.91% of applied), MB 46513 and RPA 104615 (each at 8% of applied). Organic volatiles were not detected (<0.5% of applied) in the gas traps from irradiated or dark control samples. However, carbon dioxide evolution was detected (2.5% of applied) from irradiated samples.

The study (MRID 42918662) fulfills the photodegradation on soil data requirement (161-3) for fipronil. No additional data are needed at this time.

METABOLISM

Aerobic soil metabolism
MRID No. 42928663
MRID No. 44262830

Radiolabelled fipronil, applied at 0.2 µg/g, had half-lives ranging from 128 to 308 days in sandy loam and sand soils when incubated aerobically in the dark at 25°C. Major degradates of fipronil were identified as RPA 200766 (27 to 38% of applied) and MB 46136 (14-24% of applied). Minor degradates of fipronil were identified as MB 45950 (< 5%), MB 46513 (1% of applied), and MB 45897 (<1% of applied). Additionally, six unidentified degradates were detected (each < 4% of applied radioactivity) in sandy loam and sand soil samples. No discernable decline patterns were observed for the fipronil degradates during the testing period. Unextractable radioactivity accounted for 6 to 15% of the applied radioactive fipronil. Radioactive volatiles (organic + CO_2) did not account for a discernible amount of applied radioactivity.

Radiolabelled MB 46513, applied at 0.1 µg/g, had an extrapolated half-life of 630 and 693 days in loamy sand soils when incubated aerobically in the dark at 25°C. Major metabolites were RPA 105048 (5-amino-3-carbamoyl-1-(2,6-dichloro-4-trifluoromethylphenyl)-4-trifluoromethylsulfonyl pyrazone). RPA 105048 reached a reported maximum concentration of 0.014 ppm and 0.017 (14% and 17% of applied, respectively). In addition, an unidentified degradate was detected at a maximum concentration of 0.003 ppm or 3% of applied radioactivity. Radiolabelled volatiles (organic + CO_2) were also detected (≤2% of applied radioactivity).

The registrant submitted aerobic soil metabolism data for MB 46513. Since no aerobic soil metabolism data are available for the other fipronil degradates, it is assumed the fipronil degradates are persistent ($t_{1/2}$=700 days; stable) in terrestrial environments.

The study (MRID 42928663) in conjunction with the degradate metabolism study (MRID 44262830) fulfills the aerobic soil metabolism (162-1) data requirement for parent fipronil and MB46513. No additional data are needed at this time. EFED notes the registrant assumes that fipronil degradates MB45950 and MB46136 are persistent in terrestrial environments. Further refinement of the comprehensive fate and exposure assessment for fipronil would require additional data on aerobic soil metabolism of MB45950 and MB46136.

Anaerobic Aquatic Metabolism (162-3)
MRID No. 43291704

Radiolabelled fipronil, applied at 0.75 ppm in water or 1.5 ppm in soil, had half-lives of 116-130 days in anaerobic pond water/sediment when incubated under N_2 in the dark. Major degradates of fipronil were MB 45950 (47% of applied) and RPA 200766 (18% of applied). MB 45950 was predominantly detected in the soil extracts. In contrast, RPA 200766 was detected in both water and soil extracts. Numerous minor degradates (≤6% of the applied radioactivity) were detected in soil and water extracts. Unextractable radioactivity accounted for ≈18% of the applied radioactive fipronil.

The study (MRID No. 43291704) fulfills the anaerobic aquatic metabolism (162-3) and anaerobic soil (162-2) data requirement for fipronil. No additional data are needed at this time.

Aerobic Aquatic Metabolism (162-4)
MRID No. 44261909, 44262826

Radiolabelled fipronil, applied at 0.05 ppm (w/w), rapidly degraded ($t_{1/2} \approx 14.5$ days) in sandy loam soil when incubated under stratified redox conditions in the dark at 25°C. Parent fipronil had a maximum concentration of 0.0497 ppm (0.05 ppm application rate) at time 0 (immediately posttreatment), 0.0009 ppm at 90 days posttreatment, and < 0.0003 ppm at 365 days posttreatment. Major metabolites of fipronil were MB 45950 (82.58% of applied at 365 days posttreatment) and RPA 200766 (11.09% of applied at 60 days). Minor metabolites were RPA 105048 (7.73% of applied) and MB 46513 (0.33% of applied). Two unidentified metabolites had maximum concentrations ranging from 3.34 to 4.58% Organic volatiles had a maximum cumulative concentration of 0.0005 ppm. Radioactive CO_2 had a maximum cumulative concentration of 0.001 ppm (% of applied).

Radiolabelled fipronil had half-lives of 16 and 35 days in stratified whole system water/sediment from United Kingdom. Fipronil disappearance from the water column was associated with the formation of MB45950 on sediment. The maximum concentration of MB45950 was 80% of applied radioactivity at 121 days posttreatment. Minor degradation products(<10% of applied) were RPA 200766 and MB46126.

The aerobic aquatic metabolism (162-4) data requirement is fulfilled at this time. The study (MRID 44261909) inconjunction with the aerobic aquatic metabolism study (MRID 44661301) provide marginally acceptable data on the aerobic aquatic metabolism of fipronil. The data are deemed as marginally acceptable because the aerobic aquatic metabolism studies were conducted in stratified redox conditions which confounds interpretations on aerobic metabolism processes in aquatic environments. All the available data indicate fipronil degradation is dominated by anaerobic metabolism in the sediment as evident by the formation of MB45950. The main uncertainty is the persistence of fipronil in slightly acid (pH 5.5 to 7.0), oxic sediments. No additional data are needed at the time.

MOBILITY

Leaching mobility study (163-1)
MRID No. 42918664
MRID No. 43018801 and 44039003

Radiolabelled fipronil had Freundlich coefficients of 4.19 mL/g (1/n=0.947; K_{oc}= 1248) for sand loam soil, 9.32 mL/g (1/n=0.969; K_{oc}= 800) sandy clay loam soil, 10.73 mL/g (1/n=0.949; K_{oc}=673) for Speyer 2.2 soil, 14.32 mL/g (1/n=0.947; K_{oc}=427) for sandy clay loam soil, and 20.69 mL/g (1/n= 0.969; Koc=486)for loam soil. Desorption coefficients for fipronil ranged from 7.25 to 21.51 mL/g. Fipronil sorption appears to be lower (K_f< 5 mL/g) on coarse-textured soils with low organic matter contents. These data suggest that fipronil sorption on soil is not a completely reversible process. Since the fipronil sorption affinity correlates (r= 0.97) with soil organic matter content, fipronil mobility may be adequately described using a K_{oc} partitioning model. Soil column leaching studies confirm the potential immobility of fipronil.

Radiolabelled fipronil was relatively immobile (>80% of the applied radioactivity in the 0-to-8 cm segment) in soil columns for five different foreign soils including a German loamy soil, Manningtree UK loamy sand (called sandy loam in study), Manningtree UK loam, French sandy clay loam (1), and French sandy clay loam (2). In the Manningtree UK loamy-sand soil, however, radiolabelled fipronil residues were detected in the 0-14 cm segment. Radioactive fipronil residues (1-8% of applied) were detected in leachate samples from all test soils. Leachate residues were not identified.

Radiolabelled MB 46513 had Freundlich adsorption coefficients of 4.3 mL/g (K_{oc}=1150 mL/g) for sand soil, 5.1 mL/g (K_{oc}= 1498 mL/g) for loamy sand soil, 5.5 mL/g (K_{oc}=1164 mL/g) for silt loam soil, 15.2 mL/g (K_{oc}=1245 mL/g) for clay, and 69.3 mL/g for pond sediment (K_{oc}=1392). Initial desorption coefficients of MB46513 are 5.8, 5.9, 6.2, 14.7, and 66.2 mL/g for sand, loamy sand, silt loam, clay, and pond sediment, respectively. All soils and sediment showed increasing K_{des} values (cycle 2 K_{des} values ranged from 6.9 to 73.6 mL/g and cycle 3 K_{des} values ranged from 9.5 to 85.9 mL/g) for successive desorption cycles. These data suggest that MB 45950 sorption on soil is not a completely reversible process.

The degradates MB 45950 and MB 46136 have a moderate to high sorption affinity to organic carbon. Interim data indicate MB46136 had K_{oc} adsorption coefficients of 5310 mL/g in a silt loam soil, 4054 mL/g in a sandy loam soil, 6745 mL/g in a loam soil, 3486 mL/g in a sandy clay loam soil, and 1448 mL/g in silt loam soil. MB 45950 had K_{oc} adsorption coefficients of 2404 mL/g in a silt loam soil, 3120 mL/g in a sandy loam soil, 2925 mL/g in a loam soil, 3521 mL/g in a sandy clay loam soil, and 1619 mL/g in silt loam soil.

Aged soil column leaching studies demonstrated immobility of RPA 200766, MB 45950, MB 46136 and RPA 104615. RPA 200766 was detected (2-17% of applied) in all soil columns except the Manningtree sandy loam. Detections of MB 45950 and MB 46136 were more sporadic in soil columns. Radioactive residues were detected (< 1 to 4% of applied radioactivity) in leachate samples. Leachate residues were not identified.

The unaged residue mobility studies (MRID No.43018801 and 42918664) fulfill the batch equilibrium/adsorption-desorption data (163-1) requirement for fipronil. The aged residues mobility studies (MRID No. 43018801 and 42918664) in conjunction with batch equilibrium studies on MB 46513 (MRID 44262831), MB 46136 and MB 45950 (Theissen, 10/97) should fulfill the aged portion of the 163-1 data requirement. EFED notes the batch equilibrium data for MB 46136 and MB 45950 were taken from interim reports. Complete study submissions for the interim reports are needed to confirm the validity of the batch equilibrium data.

DISSIPATION

Terrestrial field dissipation (164-1):
MRID No. 43291705, 43401103, 44298001

Fipronil, applied as REGENT 1.5G at an in furrow rate of 0.13 lbs a.i./A, had dissipation half-lives ranging from 3.4 to 7.3 months in a loam soil in San Juan Bautista, CA, a clay loam soil in York, NE, a sand soil in Clayton, NC, and a loamy sand soil in Ephrate, WA. Degradation products of fipronil detected in field soils were MB 46136, MB 45950, and RPA 200766. Fipronil residues were detected predominately in the top 0 to 15 cm soil depth at all test sites. However, there was detection of fipronil, MB 45950, MB 46136 and RPA 200766 at a depth of 15 to 45 cm for in-furrow treatments on coarse sandy loam soil in Ephrata, Washington. Although the field dissipation half-life of individual residues was not reported, the half-live of combined fipronil residues (including fipronil, MB 46136, MB 46513, MB 45950, and RPA 200766) ranged from 9 to 16 months.

Fipronil, applied at a rate of 0.05 lbs a.i/A, had dissipation half-lives of 1.1 months for bare ground on sand soil in Florida, 0.4 months for turf on a sand soil in Florida , 1.5 months for bare ground on loamy sand soil in North Carolina, and 0.5 months for turf on sandy loam soil in North Carolina. MB 46136 and RPA 200766 were detected (>2 µg/kg) in field soil samples. MB 46136 had a maximum concentration ranging from 5.6 to 8.9 µg/kg at 2-3 months post treatment. RPA 200766 was detected in bare ground samples at a maximum concentration of 3.7 µg/kg at 3 months posttreatment. Despite excess rainfall/irrigation levels, the fipronil residues remained in the upper 6 inch soil layer at each location during the 4 month testing period. Although the field dissipation half-life of individual residues was not reported, the half-live of combined fipronil residues (including fipronil, MB 46136, MB 46513, MB 45950, and RPA 200766) ranged from 2.5 to 5.33 months. EFED notes there was generally a poor fit (R^2=0.3 to 0.7) of the first-order degradation model to describe combined fipronil residue dissipation.

Fipronil, foliar applied as 80 WG at a rate of 0.3 lbs ai/A, had half-lives ranging from 132 to 159 days on a California cotton site, 14 to 31 days on Texas cotton site, and 193 days on Washington potato site. Fipronil residues (fipronil, MB45950, MB46136, MB46513, and RPA200766) had half-lives of 478 days for the California site, 134 days for the Texas site, and 745 days for the Washington site. Because the registrant did not provide a site water balance (total precipation & rainfall minus pan evaporation) , a leaching assessment cannot be made at this time. However, the field dissipation data indicate fipronil residues did not appear to leach below the 0.3 m soil layer. The detection of MB46136 and MB46513 indicate that photodegradation and microbial-mediated degradation are probable routes of field dissipation for foliar-applied fipronil.

The field dissipation studies (MRID 43291705 and 43401103) in conjunction with the registrant's rebuttal (MRID 44298001) provide an understanding of field dissipation of fipronil and its degradation products for in-furrow and turf uses. The field dissipation study (MRID 44262826) for cotton is deemed as supplemental because a field water balance could not be estimated. EFED is requesting pan evaporation data to assess the leaching potential for each site. Upon receipt and review of the pan evaporation data, the data will be reviewed for the leaching potential.

ACCUMULATION

Fish Accumulation (165-4):
MRID No. 43291706, 43291707, 44298002

The bioconcentration factor (BCF) of radiolabelled fipronil, applied at a constant concentration of ≈900 ng equiv.L^{-1}, in bluegill sunfish was 321X in whole fish, 164X in edible tissue, and 575X in non-edible tissues. Major fipronil residues in fish tissues were identified as MB 46136, MB 45897, and MB 45950. In edible fish tissues, the maximum residue concentration was 55% of accumulated for MB 46136, 14% of accumulated for MB 45897, and 9% of accumulated for MB 45950. In inedible fish tissues, the maximum residue concentration was 59% of accumulated for MB 46136, 23% of accumulated for MB 45897, and 9% of accumulated for MB 45950. In whole fish tissues, the maximum residue concentration was 28% of accumulated for MB 46136, 24% of accumulated for MB 45897, and 9% of accumulated for MB 45950. RPA 200766 was as a minor degradate in fish tissues. Accumulated fipronil residues were eliminated (>96%) after a 14 day depuration period.

The studies MRID 43291706 and 43291707 in conjunction with rebuttal comments, MRID 44298002, satisfy the bioaccumulation in fish (165-4) data requirement. No additional data are needed at this time.

Appendix C: Toxicity to Terrestrial Animals

i. Birds, Acute and Subacute

The acute oral toxicity data for birds exposed to fipronil is summarized in table 1 below. The oral toxicity to fipronil is extremely variable among species tested. Fipronil is very highly toxic to bobwhite quail, partridge, and pheasant, yet nearly non-toxic to the pigeon, house sparrow, and mallard duck. The degradate MB 46513 is 2 times more orally toxic to bobwhite quail than the parent compound and was 4 times more orally toxic to the mallard duck.

Table 1. Avian Acute Oral Toxicity Findings

Species	% A.I.	LD_{50} (CLs) (mg/kg-bw)	NOEC (mg/kg-bw)	MRID No. Author/Year	Classification
Northern bobwhite	96	11.3* (9-14)	< 4	429186-17 Pedersen (1990)	Core
Mallard duck	96.8	>2150	2150	429186-16 Pedersen(1990)	Core
Pigeon	97.7	>500	N.R.	429186-13, Hakin and Rodgers(1991)	Supplemental
Red-legged partridge	95.4	34 (28-42)	16	429186-14 Hakin and Rodgers(1992)	Supplemental
Pheasant	95.4	31 (22-44)	5	429186-15 Hakin and Rodgers(1992)	Supplemental
House sparrow	96.7	1000 (742-1691)	<464	429186-18 Pedersen and Helsten(1991)	Supplemental
Northern bobwhite	99.7 MB46513	5 (2.4-12)	3.16	437766-01 Pedersen and Solatycki(1993)	Supplemental
Mallard duck	98.6 MB46513	420 (298-581)	147	437766-02 Helsten and Solatycki(1994)	Supplemental
Northern bobwhite	1.6 WG	1065 (700-1400	175	429186-19 Pedersen and DuCharme(1993)	Supplemental

* 30% mortality at 10 mg/kg-bw and 0% mortality at 4.6 mg/kg-bw. NOEL=1 mg/Kg

Table 2 summarizes the available avian subacute dietary toxicity data. Fipronil is very highly toxic to bobwhite quail on a subacute dietary basis, yet is practically non-toxic to mallard duck on a subacute basis. The dietary toxicity assessment is based on less extensive data set than the acute oral toxicity assessment. Therefore, it is not certain whether the wide species sensitivity seen in oral testing would also be displayed in dietary studies. The reviewer assumes that this is a possibility that must be considered in assessing potential risk. In addition, there are dietary toxicity data for the fipronil degradate MB46513. The dietary toxicity of 119.2 mg/Kg-diet for the degradate is somewhat lower than that of fipronil as indicated.

Table 2. Avian Subacute Dietary Toxicity Findings

Species	% A.I.	LC_{50}(CLs) (mg/kg-diet)	NOEC (mg/kg-diet)	MRID No. Author/Year	Classification
Northern bobwhite	95% Tech.	48.0 (38-59)*	19.5	429186-20 Pedersen(1993)	Core
Mallard duck	95% Tech.	>5000(N.A.)	1250	429186-21 Pedersen(1993)	Core
Northern Bobwhite	97.8 MB545 13	119.2	18.6	492592-01 Gallagher, et. al. (2000)	Core
Northern bobwhite	97.8 MB545 13	<178	-	449207-01	Supplemental
Northern bobwhite	97.7 MB461 36	84	_	448903-01	Core
Northern bobwhite	97.8 MB459 50	114	-	448903-02	Core

* 20% mortality at 35 ppm and 0% mortality at 16 ppm(NOEL).

ii. Birds, Chronic

The avian reproductive studies (Table 3) indicate that fipronil had no effects at the highest levels that were tested in mallard (NOEC=1000 mg/kg-diet) and bobwhite quail (10 mg/kg-diet). The bobwhite NOEC of 10 ppm, which was the highest level tested, will be used as the chronic effects regulatory endpoint pending further studies for terrestrial avian species.

Table 3. Avian Reproductive Toxicity Findings

Species	% A.I.	NOEC (mg/kg-diet)	LOEC (mg/kg-diet)	Endpoint Affected	MRID No. Author/Year	Classification
Northern bobwhite	96.7 Tech.	10	Not Determined	None	429186-22 Pedersen and DuCharme(1993)	Supplemental
Mallard duck	96.7 Tech.	1000	>1000	None	429186-23 Pedersen and Lesar (1993)	Core

The guideline (71-4) is partially fulfilled (MRID 429186-23). The northern bobwhite quail study (MRID 429186-22) does not fulfill guideline requirements, and the need for a new study is apparent unless the present proposed use will not produce terrestrial EECs above 10 mg/kg-diet. Based on estimated residue levels for in furrow use on corn, the current study will be adequate. Using body weight and feed consumption data for the 10 mg/kg-diet exposure the mean bodyweight over the course of the study was 209.1 g (0.2091 kg) and the mean food consumption rate was 18.3 g/day (0.0183 kg/day). Applying these two mean values to the dietary

NOEC of 10 mg/kg-diet, yields an oral dose NOEL estimate of 0.88 mg/kg-bw/day. Estimation of this NOEL is necessary for assessing risk through the oral consumption of fipronil and its degradates from in-furrow spray applications.

iii. Mammals, Acute and Chronic

Wild mammal testing is required on a case-by-case basis, depending on the results of the lower tier studies such as acute and subacute testing, intended use pattern, and pertinent environmental fate characteristics. In most cases, however, an acute oral LD_{50} from the Agency's Health Effects Division (HED) is used to determine toxicity to mammals (HED Tox One-liners). These $LD_{50's}$ are reported in Table 4. The available mammalian data indicate that fipronil (Technical) is moderately toxic to small mammals on an acute oral basis. The 1.6% in EXP60655A and 0.25% in RM1601C formulations of fipronil did not demonstrate significant mammalian dietary toxicity.

Table 4. Mammalian Acute Oral Toxicity Findings

Species	% AI	LD_{50} (mg/kg-bw)	MRID	Category
Rat (small mammal)	93%	97	429186-28	Mod. Toxic
Rat (small mammal)	MB46136 degr.(98%)	218	429186-75	Mod. Toxic
Rat (small mammal)	1.6(form.) EXP60655A	>5000	429186-36	P.Non-Toxic
Rat (small mammal)	0.25(form.) RM1601c	>5000	431211-04	P.Non-Toxic

Fipronil and desulfinyl fipronil (MB46513) were evaluated for persistence and metabolism in male Swiss-Webster mice as well as comparative acute toxicity (intraperitoneal administration) and affinity for the mouse GABA receptor (Hainzl and Casida, 1996). Groups of mice received five daily 1 mg/kg doses of fipronil or MB46513, i.p. Mice were sacrificed at day 6 and day 27 and adipose tissue was analyzed for fipronil and degradates. Adipose tissue of fipronil treated mice contained only the sulfone metabolite of fipronil (MB46136). MB46513 treated mice contained only this photodegradate in adipose tissue, suggesting no metabolism of the compound. Adipose concentrations of MB46136 and MB46513 were at a maximum at day 6 (22-24 mg/kg fat) but by day 27 these concentrations had been reduced to 0.8 to 3.2 mg/kg. The neurotoxic potency of fipronil was maintained or possibly increased upon the formation of desulfinyl derivatives of fipronil. The acute i.p. LD_{50} for fipronil in mice was 41 mg/kg, while the LD50 for MB46513 was 23 mg/kg, suggesting the potential for comparable toxicity between fipronil and the photodegradate in mammalian systems. It is noteworthy that MB46513 exhibits a greater affinity for the mouse GABA receptor (IC_{50} 94 nM) than parent fipronil (IC_{50} 1010 nM). The toxicity data and GABA receptor data suggest that risk assessments for uses of fipronil where the photodegradate can be expected to be produced should assess the potential toxicological implications of this degradate.

A number of toxicological studies involving subchronic and chronic exposure of mice, rats, and dogs to fipronil are available. These studies address a variety of toxicological endpoints including neurological function, thyroid function, carcinogenicity, histology, reproductive effects, and developmental effects. EFED has concentrated the toxicological evaluation of effects on mammalian systems to those effect endpoints expected to be of the highest ecological relevance. Concern for wild mammal population maintenance focused this evaluation on effects to individual fecundity and survivability of offspring. Therefore, EFED has concentrated on reproductive and developmental endpoints. A multi-generation reproduction study in CD rats (MRID 429186-47) is the source of reproductive toxicity data for this assessment. Thirty-six CD rats/sex/group received fipronil continuously in the diet at concentrations of 0, 3, 30, and 300 mg/kg diet. This study reported decreased litter size in F_1 and F_2 litters and a decrease in the percentage of F_1 parental animals mating at the maximum dose tested 300 mg/kg-diet. In addition, this high dose produced reduced post-implantation and postnatal survivals in F_2 litters. The NOEL for these effects is 30 mg/kg-diet (HED equivalence to 2.54 mg/kg-bw males, 2.74 mg/kg-bw females) and the LOEL is 300 mg/kg-diet (HED equivalence to 26.03 mg/kg-bw males, 28.4 mg/kg-bw females).

iv. Insects

The Agency cannot characterize the risk of adverse impacts to beneficial insects from application of fipronil insecticide products. The honeybee acute contact LD_{50} and the honeybee residue study on foliage are not needed to support in-furrow applications to corn. However, the studies will be needed to support foliar groundspray and aerial application of fipronil. To date, the agency has only received a honeybee residue study on foliage. It is assumed that hazardous impacts to honeybees and other beneficial insects are unlikely if fipronil is properly incorporated. It is also assumed that fipronil has been tested by the registrant and found to be highly toxic to honeybees as there is a label statement to this effect on the REGENT 80 WG label. Impacts to beneficial soil invertebrates, such as earthworms, are probable given the mode of action for fipronil and it's incorporation into soils.

Appendix D. Aquatic Organism Toxicity

Table 1 summarizes the freshwater and marine fish data reviewed to date using fipronil technical and fipronil degradates which are expected to persist in the aquatic environment. Two freshwater fish toxicity studies (with one study using a coldwater species (preferably the rainbow trout) and the other a warmwater species (preferably the bluegill sunfish) are required. A fish study with the sheepshead minnow is required for marine/estuarine fish.

Table 1. Freshwater and Marine Fish Acute Toxicity Findings

Species	% A.I.	LC_{50} (CLs) (µg/L)	NOEC (µg/L)	MRID No.	Classification
Freshwater Species					
Bluegill sunfish	100 Tech.	83(72-98)	43	429186-24	Core
Rainbow trout	100 Tech.	246(205-342)	34	429779-02	Core
Channel catfish	97 Tech.	560	-	44299-01	Core
*Rainbow trout	99.2-deg. (MB46136)	39(34-43)	18	429186-73	Supplemental
*Bluegill sunfish	99.2 deg. (MB46136)	25(21-30)	6.7	429189674	Supplemental
*Raimbpw trpit	100 deg (MB46513)	>100,000	36,000-	432797-03	Core
*Raimbpw trpit	94.7 deg (MB46513)	>100,000	-	432917-18	Core
*Bluegill sunfrish	(MB46513)	20	-	157298	Supplementsal
*Rainbow trout	94.7 photo-degr. (RPA104615)	>100,000	NA	432917-18	Supplemental
Marine/Estuarine Species					
Sheepshead minnow	96.1 Tech.	130(110-280)	<110	43291702	Core

* Studies used aerobic metabolic degradates/metabolites of Fipronil.

The results of the 96-hour acute toxicity studies (Table 1) indicate that fipronil (Technical) and MB46136 degradates are very highly or highly toxic to bluegill sunfish, rainbow trout and sheepshead minnow (estuarine). The metabolites RPA 104615 and MB46513 appears to be nearly non-toxic to fish. The guidelines for freshwater fish are fulfilled. Additional studies for degradates will need to be performed if levels of concern are exceeded for the parent fipronil.

Data from fish early life-stage tests (Table 2) were required for fipronil due to the high acute toxicity of the parent, persistence characteristics, and the probability fipronil will enter bodies of water from the continued use on corn.

Table 2. Fish Early Life-Stage Toxicity Findings

Fish Early Life-Stage Toxicity Findings						
Species Tested	**% A.I.**	**NOEC (µg/L)**	**LOEC (µg/L)**	**MRID Author/Year**	**Endpoints Affected**	**Category**
Rainbow trout	96.7 Tech.	6.6	15	429186-27 Machado(1992)	Larval length	Core
Sheepshead minnow	97	0.24	0.41	44605502	Length/weight	Core

The results indicate that fipronil affects larval growth at concentrations greater than 6.6 µg/L, but less than 15 µg/L in rainbow trout. However, in marine fish species the results are much more dramatic. Both length and weight are affected at concentrations greater than 0.24 µg/L but not less than 0.41 µg/L.

Data from a marine fish full life-cycle test (Table 3) was required for fipronil due to the high chronic toxicity of the parent, persistence characteristics, and the probability fipronil will enter bodies of water from the continued use on corn.

Table 3. Fish Full Life-Cycle Toxicity Findings

Fish Early Life-Stage Toxicity Findings						
Species Tested	**% A.I.**	**NOEC (µg/L)**	**LOEC (µg/L)**	**MRID Author/Year**	**Endpoints Affected**	**Category**
Sheepshead minnow	95	0.85	1.7	45265101	Length	Core

Data from the marine fish full life cycle test (Table 3) show that growth affects (length) are demonstrated at test concentrations greater than 0.85 µg/L, but not less than 1.7µg/L. These results appear to suggest that marine fish exhibit higher chronic sensitivity than freshwater fish.

A freshwater aquatic invertebrate toxicity test (preferably using first instar *Daphnia magna* or early instar amphipods, stoneflies, mayflies, or midges) is required. The data is presented in Table 4.

Table 4. Freshwater Invertebrate Acute Toxicity Findings

Species Tested	% A.I.	48-h EC_{50} (µg/L)	MRID NO. Author/Year	Classification
Daphnia magna	100 Technical	190	429186-25 McNamara(1990)	Core
Daphnia magna (see 21 Day study)	100 % technical	39 (21 Day)	429186-26 McNamara(1990)	Supplemental
Daphnia magna	*94.7 photodeg. RPA 104615	100,000	432917-19 Collins(1992)	Supplemental
Daphnia magna	100% MB 46136 degradate	29	429186-71 McNamara(1990)	Supplemental
Daphnia magna	*100% MB 45950 degradate	100	429186-69 McNamara(1990)	Supplemental
Chironomus tepperi	20% (results adjused) RP EXP 60145a	0.43	Stevens et. al 1998	Supplemental
Red Swamp Crayfish	*96.1 ICON 6.2 FS	174	450296-01	Supplemental

* studies used different degradates/metabolites of fipronil.

There is sufficient information to characterize fipronil parent and its degradates MB46136 and MB45950 as very highly toxic to freshwater aquatic invertebrates. It should be noted that there appears to be a great difference in sensitivity between the daphnid and chironomid . The chironomid study from the sediment toxicity study shows a similar sensitivity to this chronomid study. Therefore, additional data on other species which might shed light on the toxicity profile of fipronil. Suggested species which should be tested are mayflies, stoneflies, and caddis flies. In addition, the MB 46513 degradate should be tested.

Because fipronil is proposed for use on crops which may be located adjacent to estuarine habitats, aquatic invertebrate testing with estuarine marine invertebrate species was required. Table 5 summarizes the results of these studies.

Table 5. Estuarine/Marine Invertebrate Acute Toxicity Results

Species	% A.I.	LC_{50}/EC_{50} (CIs) (µg/L)	MRID No. Author/Year	Classification
Eastern oyster	96.1	EC50=770 (180-1700)	432917-01 Dionne/1993	Core
Mysid	96.1	EC50=0.14 (0.12-0.16)	432797-01 Machado/1994	Upgraded to core
Mysid	97.8 MB 46513	EC50=1.5	451200-01	Core
Mysid	99.7 MB 46136	EC50=0.56	451563-01	Core
Mysid	99,7 M1B45950	EC50=0.077	451563-02	Core

The results from these studies indicates that there is sufficient information to characterize fipronil and it's degradates as highly toxic to oysters and very highly toxic to mysids.

Data from aquatic invertebrate life cycle tests are required due to persistence of fipronil in water, high acute toxicity and the probability that the compound will enter bodies of water from the proposed use on cotton In addition, when an end-use product is intended for direct application to the marine/estuarine environment or is expected to reach this environment in significant concentrations an invertebrate life cycle test with marine/estuarine invertebrate is required. The results of these studies are presented in Table 6.

Table 6. Aquatic Invertebrate Chronic Life-Cycle Toxicity Findings

Species Tested	% A.I.	LOEC/NOEC (µg/L)	MRID No. Author/Yr	Endpoints Affected	Classification
Mysid	97.7 Tech	LOEC 0.005 NOEC not determined	436812-01 Machado/1995	Survival Reproduction and Growth	Supplemental
Mysud	99.5 MB45950	LOEC 0.0087 NOEC 0.0046	45259202	Weight	Supplemental
Mysid	99 MB46136	LOEC 0.0026 NOEC < 0.0026	45259203	Weight	Supplemental
Daphnia magna	100 Tech	LOEC 20 NOEC 9.8	429186-26 McNamara/1990	Length	Supplemental
Daphnia magna	MB46513	LOEC 100 NOEC 41	432797-04	Growth	Core
Daphnia magna	MB46136	LOEC 1.5 NOEC 0.63	DPR 15730	Weight	Core
Daphnia magna	MB46950	LOEC 22 NOEC 13	DPR 15730	Reproduction, growth	Core

The results indicate that fipronil affects growth in daphnids at concentrations exceeding 9.8 µg/L (MRID 42918626). The results also indicate that fipronil affects reproduction, survival and growth of mysids at concentrations less than 0.005 μg/L (MRID 436812-01). The mysid study does not meet guideline requirements because effects occurred at all test concentrations and an NOEC was not determined. The daphnia study does not meet guideline requirements because of high mortality in the dilution water control and high variability in the analytical measurements. Both studies with daphnids and mysids indicate that chronic exposure to fipronil may result in toxic effects at water concentrations substantially below acute effect levels. This potential for chronic effects and the persistence of fipronil suggested that the mysid and daphnid chronic studies should be repeated for the parent fipronil to support full registration on cotton, corn, and rice. In addition. testing of the MB 46513 would reduce uncertainties in the risk assessment.

The freshwater Daphnid studies suggest that chronic effects of the MB46136 degradate occur at considerably lower water concentrations than that of parent(NOEC = 0.63 μg/L). Marine invertebrate studies for the degradates MB 46136 and MB45950 show the same trends as the freshwater studies except that the toxicity is considerably greater (NOEC < 0.0026 μg/L).

Due to the extreme persistence and strong tendency for the parent and degradates to sorb to sediment, acute toxicity tests were submitted for the degradates MB 46136 and MB45950. The results presented in Table 7.

Table 7. Aquatic Invertebrate Acute Toxicity for Sediment Dwelling Organism Findings

Species Tested	% A.I.	Sediment growth/mortality EC_{50} / LC_{50} (μg/kg)	Pore Water growth/mortality EC_{50} / LC_{50} (μg/L)	MRID No. Author/Yr	Classification
Chironomus tentans	99.5 MB46136	34.8 / 44.8	0.41 / 0.72	45175901	Core
Chironomus tentans	MB46950	50.9 / 116.9	0.66 / 2.13	45084801	Core

The results of these tests show acute pore water toxicity concentrations considerably higher than the freshwater daphnids. However, data from another chironomid study (Stevens, et. al.) demonstrates similar toxicity to the sediment toxicity data. Chronic sediment toxicity tests on the parent and MB 46513 degradate have not been submitted. These tests as well as acute and chronic testing on marine/estuarine sediment toxicity tests should also be submitted to reduce uncertainties in the risk assessment.

Appendix E: Toxicity to Non-Target Beneficial Insects

The honeybee acute contact LD_{50} and the honeybee residue study on foliage are not needed to support in-furrow applications to corn. However, the studies will be needed to support foliar groundspray and aerial application of fipronil. To date, the agency has only received a honeybee residue study on foliage (MRID #: 448841-01). The final report of this study is currently under review. It is assumed that the acute contact studies have been conducted because previous label warnings have advised that fipronil is highly toxic to honeybees.

Appendix F: Toxicity to Terrestrial Plants

Currently, terrestrial plant testing is not required for pesticides other than herbicides except on a case-by-case basis (*e.g.*, labeling bears phytotoxicity warnings incident data or literature that demonstrate phytotoxicity). A literature search conducted by EFED revealed that continuous seed exposure to fipronil (four days) at 2000 mg/L significantly imparied seed germination in rice.[1] However, fipronil is currently registered for seed treatment on rice at a rate of 0.05 lb ai.A. When converted, this application rate is equivalent to 22680 mg ai/A. This acreage can be converted to 5.6 mg ai/m^2. In order to convert the area covered in a square meter to a volume equivalent one could make the assumption that a 0.108 m water depth occupying a square meter would yield the volume equivalent of 1000 cm^3 or 1 Liter. The final concentration occupying this hypothetical 1 Liter volume would be 0.52 mg ai/L. This concentration is more than three orders of magnatude below the 2000 mg/L seed germination impairment endpoint. Therefore, EFED will not ask for terrestrial plant data at this time.

Appendix G: Toxicity to Aquatic Plants

Generally the Agency does not require terrestrial or aquatic plant testing for insecticide products. However, Tier I aquatic plant testing was provided due the probability that drift to aquatic habitats will occur from aerial applications to cotton. Table 1 presents the available data for 5 aquatic plant species.

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[1]Stevens, M.M., Fox KM; Coombes NE; Lewin LA (E-Mail: mark.stevens@agric.nsw.gov.au), Effect of fipronil seed treatments on the germination and early growth of rice, NSW Agr, Yanco Agr Inst, Private Mail Bag, Yanco, NSW 2703, Australia, PESTICIDE SCIENCE , 1999 , Volume: 55 , Number: 5 (MAY) , Page: 517-523.

Table 1. Nontarget Aquatic Plant Toxicity Findings

Species Tested	% A.I.	5 Day EC50 (µg/L)	NOEC (µg/L)	MRID # Author/year	Classification
Navicula pelliculosa (FW diatom)	96.1	>120	120	42918658 Hoberg/1993	Core
Lemna gibba (Duckweed)	96.1	>100	100	42918656 Hoberg/1993	Supplemental
Selenastrum capricornutum (FW green alga)	96.1	140	<140	42918660 Hoberg/1993	Core
Skeletonema costatum (marine diatom)	96.1	>140	140	42918659 Hoberg/1993	Core
Anabaena flos aquae (FW Blue-green alga)	96.1	>170	140	42918657 Hoberg(1993)	Core